THURSDAY, APRIL 14, 1898.

HABIT AND INSTINCT.

Habit and Instinct. By C. Lloyd Morgan, F.G.S. Pp. 351. (London: Edwin Arnold, 1896.)

THE substance of this interesting work was delivered in 1896, as a course of Lowell Lectures at Boston, and as lectures in other parts of the United States.

The arrangement of the book is excellent: the first chapter deals with "Preliminary Definitions and Illustrations," the second, third, and fourth with original observations of the author upon the young of many species of birds; the fifth, with observations upon young mammals. These four chapters form the chief material upon which, in the remainder of the volume, a very interesting and important discussion upon animal habits and instincts is carried on, concluding with the consideration, in the twelfth, thirteenth, fourteenth and fifteenth chapters, of the following subjects, which present so many aspects of wide interest:—"The Relation of Organic to Mental Evolution," "Are Acquired Habits inherited?" "Modification and Variation," "Heredity in Man."

In the preliminary discussion in the first chapter a very beautiful example of a complex instinct is afforded in the behaviour of the Yucca moth (*Pronuba yuccasella*).

"The silvery, straw-coloured insects emerge from their chrysalis cases just when the large, yellowish-white, bell-shaped flowers of the yucca open, each for a single night. From the anthers of one of these flowers the female moth collects the golden pollen, and kneads the adhesive material into a little pellet, which she holds beneath her head by means of the greatly enlarged bristly palps. Thus laden, she flies off and seeks another flower. Having found one, she pierces with the sharp lancets of her ovipositor the tissue of the pistil, lays her eggs among the ovules, and then, darting to the top of the stigma, stuffs the fertilising pollen-pellet into its funnel-shaped opening."

"Now, the visits of the moth are necessary to the plant. It has been experimentally proved that, in the absence of the insects, no pollen can get to the stigma to fertilise the ovules, and the fertilisation of the ovules is necessary to the larvæ, which in four or five days are hatched from the insect's eggs. It has been ascertained that they feed exclusively on the developing ovules, and in the absence of fertilisation the ovules would not develop. Each grub consumes some twenty ovules, and there may be three or four such grubs. But the ovary contains some two hundred ovules. Of these, therefore, say, a hundred are sacrificed to the grubs of that moth, through whose instrumentality alone the remaining hundred can be fertilised and come to maturity."

Concerning this elaborate sequence of actions the author points out that they are performed but once in the lifetime of the moth, without instruction, without imitation, and without the guidance which an experience of the subsequent fate of the eggs might provide. The essentially adaptive nature of the sequence is insisted upon.

The relation between what is "congenital" and what is "acquired" is considered in some detail, and by many examples, especially that of the training of falcons, it is shown that the limits of what can be acquired are determined by what is congenital.

"The behaviour of a trained falcon is an adaptation and modification of the hawk's congenital instincts as a bird of prey. The finished performance is part instinct and part habit. The basis is instinctive and congenital; the modification is a matter of acquired habit."

This valuable preliminary discussion of the subject-matter of the volume is summed up in the following statement—

"From the biological point of view . . . instincts are congenital, adaptive, and coordinated activities of relative complexity, and involving the behaviour of the organism as a whole. They . . . are similarly performed by all like members of the same more or less restricted group, under circumstances which are either of frequent recurrence or are vitally essential to the continuance of the race. While they are, broadly speaking, constant in character, they are subject to variation analogous to that found in organic structures. They are often periodic in development and serial in character. They are to be distinguished from habits which owe their definiteness to individual acquisition and the repetition of individual performance."

The author has rendered a great service in thus bringing together the essential characteristics of instinct as opposed to habit in a few clear brief sentences.

The interesting experiments of the author upon the activities and instincts of young birds must be read in full to be properly appreciated. They have a most important bearing upon problems of very wide interest, such as the hereditary transmission of acquired characters, the theories of Protective Resemblance, Protective Mimicry, Warning Coloration, &c. These experiments and observations should be studied carefully by all who either criticise or support the above-mentioned theories. The general results only can here be indicated.

The observations of Douglas Spalding (*Macmillan's Magazine*, February 1873) upon young chickens have been much quoted, but many of his conclusions are here shown to be without sufficient foundation. Thus Lloyd Morgan's observations do not support the conclusion that there is any instinctive recognition of the mother hen by the young chick which sees or hears her for the first time. He does not find the accuracy of aim is at first equal to that recorded by Spalding, and he gives strong reasons for the belief that the evidence of instinctive fear of a bee or a hawk is not due to alarm at these animals as such, but merely one example of the extreme shyness of young birds at any unusual sight or sound.

There is no instinctive knowledge of food or water. Any object of suitable size and within the right distance is struck at; but the chicks are very quick in learning from the experience thus gained. A young chick, two days old, which had learnt to select pieces of yolk of egg, twice seized a piece of orange-peel of about the same size and shape. After this he could not be induced to touch it, and for a time refused yolk of egg. The conspicuous caterpillars of the cinnabar moth, alternately ringed with black and yellow, were thrown to some chicks, which seized but immediately dropped them and wiped their bills. Later in the day the caterpillars were again offered, and only tried once by some of the chicks.

The following day, after they had eaten many edible caterpillars, the cinnabars were again thrown to them, but the lesson had now been learnt by nearly all.

"One chick ran, but checked himself, and, without touching the caterpillar, wiped his bill—a memory of the nasty taste having been apparently suggested by association at sight of the black-and-yellow caterpillar. Another seized one, and dropped it at once. A third subsequently approached a cinnabar as it crawled along, gave the danger note, and ran off. . . . Similarly, moorhen chicks rapidly discriminated between small edible beetles and soldier beetles. Such discrimination is, however, not congenital, but acquired."

This last conclusion is of great importance for the theory of warning colours. If each generation of insect-eating animals has to learn for itself what is fit and what unfit for food, the advantage of conspicuousness to the unfit and of similarity in conspicuousness becomes much greater than under a condition of instinctive discrimination. On this point Lloyd Morgan's numerous experiments seem to leave little doubt. ". . . There does not appear to be any congenital and instinctive avoidance of such caterpillars with warning colours." Of the instinctive avoidance of distasteful insects he says, "I have not found a single instance."

The theory of mimicry, due to H. W. Bates, is also supported by the behaviour of duckling and moorhen chicks which would not touch drone-flies after having been stung by a bee and a humble-bee respectively. There was never any evidence of an instinctive knowledge of the hurtful nature of bees and wasps. A very young bird, after being once stung, is shy for a long time not only of bees, but of various kinds of insects. An older one, after a similar experience, is in the main only shy of the stinging insect and others that closely resemble it.

There is an interesting description of the manner in which the excreta are prevented from fouling the nest, being voided over the edge or carried away by the parent birds. A friend of the author observed that the young of swallows,

"after being fed by their parents, were nudged and pushed until they turned round and voided excrement, which was immediately seized by the parent bird with the tip of the beak, carried away, and dropped outside."

When the present writer was a boy, he (together with his father and sister) witnessed a proceeding on the part of a parent thrush which made a very deep impression upon him. The parent bird was seen to alight on the edge of its nest, and thrust its beak into the gaping bill and deeply down into the throat of one of its young, and draw forth a large black and white worm-shaped object (apparently from 1½ to 2 inches in length), which it then swallowed. The nest was only a few feet away, below the window of a summer-house, which afforded a perfect view of the performance. It is probable that the observation, which has been up to the present time unintelligible to the writer and those friends whom he has consulted, is to be explained as one form of an instinct of which other forms are recorded here.

The earliest activities in walking, diving, and flying are described in a most interesting chapter which proves the extraordinary congenital accuracy with which these complex associated movements are performed. It is argued with great force that the opportunity of watching the movements of older birds does not offer any sufficient explanation of the precision with which they are performed by the young for the first time. "Who ever learnt to do a difficult thing, even passably well, by merely watching it done superbly by another?" The author's observations convincingly demonstrate the truth of the same conclusion; for he watched the first attempts of this kind made by young birds hatched in an incubator. In all these the earliest associated movements were astonishingly accurate, and sometimes, as in the first dive of a startled moorhen chick (p. 64), incapable of further improvement. Speaking of this example the author says,

"though long deferred, here was the instinctive activity in congenital purity and definiteness, and absolutely true to type, for this was the very first time he had ever dived, nor had he ever seen any bird do so."

The precision and freedom with which swimming and diving are first performed seems to be much greater than that with which walking and flying are begun. It is not improbable that the difference is due to the further difficulty introduced by the necessity in the latter case, and especially in that of flying, of sustaining the weight of the body, and of starting and checking its movements, for the first time. It is probably this, rather than the coordination of muscular movement, which explains such hesitation and such feebleness as is at first observed. In other words it is probably the considerable strain thrown upon the muscles for the first time which prevents perfect precision, so that when this additional strain of weight is borne by the water, the accuracy of the earliest coordinated movements is much greater. Nevertheless the example of the *Megapodius*, quoted on p. 76, renders it probable that the movements of flight may be performed with complete success immediately after hatching, when they are necessary for the existence of the species.

All these statements and arguments only refer to the power of sustaining and moving the body in the air under the most favourable conditions. For the countless adjustments to the ever-varying currents of wind, it is held that very considerable individual practice is necessary. Flight in its finished form is "the result of practice and individual acquisition . . . founded on a congenital basis" (p. 78).

The conclusions to be drawn from many of these observations on young birds are summed up in a most interesting manner in Chapter iv. Thus, in the case of the associated muscular movements referred to above,

"what is inherited is a congenital coordination of motor responses under the appropriate conditions of stimulation. Not only is there inherited a given structure of leg or wing, but a nervous system through which there is an automatic distribution of outgoing currents to the several muscles concerned; so that, without learning or experience, they are called into play with nicely graded intensity, and exhibit complex contractions and relaxations in serial order, thus giving rise to instinctive behaviour of an eminently adaptive nature."

In feeding there is

"a similar congenital coordination of motor responses for pecking at a small object within a suitable distance.

But, from the observations, it seems that the selection of certain of these objects and the rejection of others is a matter of individual experience."

With regard to instinctive fear of particular animals or objects, the evidence indicated that it has no existence in relation to

"bees or wasps as such, but that there is a shrinking response, probably instinctive, from *any* largish strange object, especially if it moves vigorously or makes some such noise as buzzing."

An account of further experiments in the same direction is given in the present chapter. There was no instinctive fear of a fox-terrier dog which was trained to remain passive in the presence of the birds.

"Pheasants, partridges, and plovers would peck at his nose as he smelt at them, and run in between his legs."

"Neither chicks, pheasants, nor jays—not even the little fly-catchers—showed any signs of dread of a kitten, nor did chicks of an older cat."

It is also stated that "there is not apparently much difference in the young of wild and tame birds," in this respect. This interesting conclusion, for which much evidence is quoted, differs from that which has been drawn by Dr. Rae (NATURE, July 19, 1883). The whole of the observations on the effects produced by various animals upon young birds tend strongly to support Mr. Hudson's conclusion that the fear of particular enemies is due to experience and tradition (p. 89).

The rapidity with which associations are formed was illustrated in an amusing manner by some ducklings which had their bath in a tin placed on a tray.

"On the sixth morning the tray and tin were given them in the usual way, but without any water. They ran to it, scooped at the bottom, and made all the motions of the beak as if drinking. They squatted in it, dipping their heads and waggling their tails as usual. For some ten minutes they continued to wash in non-existent water, the coolness of the tin to their breasts perhaps giving them some satisfaction."

However, the next day they soon gave up the attempt, and "on the third morning they waddled up to the dry tin and sadly departed" (p. 96).

The congenital nature of the movements in bathing were well shown by jays and magpies. One of the latter was observed by Mr. Charbonnier "to go through all the gestures of a bird bathing" upon the floor of the cage, after pecking once or twice at the surface of water in a pan with which it had been supplied for the first time.

Some of the main general conclusions will be found summarised in seven short paragraphs at the end of Chapter iv.

The succeeding chapter deals with the young mammal. The immense difference in the activity of the newly-born young of various mammalian groups is well brought out by numerous interesting examples. Chief among the congenital associated movements of the young mammal is the act of sucking, in response to the contact of any solid substance of suitable size with the mouth. A more striking instance of the purely reflex and congenital nature of the performance, than any as yet recorded, was described to the present writer by Dr. J. Sidney Turner.

"There is no doubt whatever," Dr. Turner writes, "about the sucking reaction before birth (*i.e. before* the instinct can be in any way useful—indeed it would be the *reverse* of useful). During the process of cephalic version which is done whilst the fœtus is high up in the uterus, I have, on several occasions, placed my little finger in the mouth of the fœtus, and it has most distinctly sucked the finger exactly in the same manner as a born baby would do. . . . I don't know at what age of the embryo fœtus sucking is possible, but I know that a six months fœtus, at birth, can suck well."

It is satisfactory to be able, with Dr. Turner's permission, to put on record this interesting observation upon the human species, an observation which may well be added to the numerous others given in Chapter v.

The conclusions of Spalding and others that the kitten recognises and shows an instinctive fear of the smell of the dog are criticised, and the true inference is shown to be probably as in the case of the chick, the characteristic behaviour being only an example of congenital response to almost any strong stimulus. The responses in later life are explained as the results of experience and of parental influence. Prof. Lloyd Morgan freely admits that "there may be an instinctive basis, however, in some cases where animals are by nature enemies." The behaviour of the frog in presence of the grass-snake and of the rabbit in presence of the stoat would be especially interesting to investigate from this point of view.

It is well pointed out in this chapter that however much instincts are

"utilised, modified, and adapted through experience and acquisition, yet the fundamental distinction between that which is congenital and instinctive, on the one hand, and that which is acquired through individual experience, on the other hand, remains unaltered. . . . The instinctive action is prior to experience; the acquired action is due to experience. And this distinction holds, no matter how hard it may be to decide whether this action or that is in the main instinctive or in the main acquired."

These earlier chapters, which are full of interesting observation and acute criticism, have been drawn upon to a considerable extent in this notice; but all who are interested in the subject are bound to study the original. The limits of space prevent any further reference to the close reasoning in the important chapters which deal with the material supplied by these observations, and out of it construct for us valuable theories of animal psychology and the mode of the working of the higher parts of the nervous system in relation to instinct, intelligence, imitation, emotion, &c. It is sufficient to say that to most, probably to all, naturalists who are accustomed to reflect on such subjects the conclusions will commend themselves as those which are to be legitimately drawn from the facts.

In the interesting chapter on "Some Habits and Instincts of the Pairing Season," the author protests strongly against "the unnecessary supposition that the hen bird must possess a standard or ideal of æsthetic value, and that she selects that singer which comes nearest to her conception of what a songster should be." It may be conceded that the word "æsthetic" is an unfortunate one to use in this connection. On the other hand, the comparison between the chick which "selects the worm that excites the strongest impulse to pick it up

and eat it" and the hen which "selects that mate which by his song or otherwise excites in greatest degree the mating impulse," although doubtless perfectly true in itself, leaves unexplained and indeed unexpressed the fact that the song or plume which excites the mating impulse in the hen, is also in so high a proportion of cases most pleasing to man himself. And not only this, but in their past history, so far as it has been traced (*e.g.* in the development of the characteristic markings of the male peacock and argus pheasant), such features have gradually become more and more pleasing to us as they have acted as stronger and stronger stimuli to the hen. Why should this be?

In the chapter on nest-building, incubation and migration, there is a most effective reply to those (and they are many) who point to the "coincidence" that "congenital variation on the one hand, and intelligent choice on the other, coincide in direction and tend to the same result," as almost too much to be believed except on the supposition that the latter has through heredity given rise to the former. To this argument the author replies that both these principles are

"working, in their different spheres, towards the same end—that of adaptation. . . . Is it a coincidence in any proper sense of the term? Surely not. If two men start for the same place, the one by sea and the other by land, we should not regard it as a coincidence if both got there."

A number of interesting facts are quoted about bird migration, and the author surmises, but very cautiously, that

"while the migratory instinct is innate, and perhaps there is an instinctive tendency to start in a given direction, yet the element of traditional guidance may be effectual, in the migratory stream as a whole, in some way that we have hitherto been unable to observe" (p. 261).

The onus of proof seems certainly to rest with those who dispute this latter conclusion, and who hold so inherently improbable a view as that there is an instinctive knowledge, prior to experience, of geographical routes of enormous length and devious course. A single observation recorded by W. Warde Fowler (in the *Midland Naturalist*) a few years ago, points very strongly in the opposite direction. Mr. Fowler was standing on the English coast just opposite the western end of the Isle of Wight, but the day was misty and the island invisible. He watched the successive companies of swallows sweeping by eastward to join the migratory stream to the south, and he saw that each company followed the circuitous coast-line leading north of the island. All at once he noticed a change: a company arriving at the spot where he was standing, rose in the air and then flew to sea in an eastward direction. He then turned and saw that the mist had cleared and the island was visible. The birds were now able to take the shorter route, for they could see the way.

With regard to the question "Are acquired habits inherited?" the author in the thirteenth chapter, after a keen criticism of the evidence concludes, but with much caution, that "there is but little satisfactory and convincing evidence in favour of transmission." The appearances which have suggested an opposite conclusion to many writers are explained in the next chapter, "Modification and Variation." We have here an exposition of a most interesting and useful suggestion independently made by the author, Prof. Osborn of New York, and Prof. Mark Baldwin of Princeton. Others (*e.g.* Prof. Weismann) have previously laid more or less stress upon the same principle, but it has been due to the writings and influence of these three authorities that the matter has been put in its true light, and the principle shown to be an important contribution to organic evolution. This principle, which has been described in America by the not very self-evident term "organic selection," is thus explained by Prof. Lloyd Morgan in the work now referred to.

"If now it could be shown that, although on selectionist principles there is no transmission of modifications due to individual plasticity, yet these modifications afford the conditions under which variations of like nature are afforded an opportunity of occurring and of making themselves felt in race progress, a farther step would be taken towards a reconciliation of opposing views."

A case is then considered: suppose there is a change of environment and the congenital variations are not equal to the occasion, "individual plasticity steps in to save some members of the race from extinction . . . through a modification of the bodily tissues." In this way time is given for the appearance of congenital variations in the same direction, which is therefore rendered possible by the power of individual modification.

"Thus, if the conditions remain constant for many generations, congenital variation will gradually render hereditary the same strengthening of . . . structure that was provisionally attained by plastic modification. The effects are precisely the same as they would be if the modification in question were directly transmitted in a slight but cumulatively increasing degree; they are reached, however, in a manner which involves no such transmission." In this way "we may accept the facts adduced by the transmissionist, and at the same time interpret them as selectionist principles."

This principle is, in the opinion of the present writer, a valuable aid in the attempt to understand the evolution of the organic world. It should be observed, too, that the author does not intend any part of this principle as a substitute for natural selection; for he fully recognises that the "innate plasticity" is as much a product of natural selection as "congenital definiteness" (p. 319).

The last chapter deals with "Heredity in Man"; and here the author concludes that

"mental progress is mainly due, not to inherited increments of mental faculty, but to the handing on of the results of human achievement by a vast extension of that which we have seen to be a factor in animal life, namely tradition."

In his final summary he states that

"there is little or no evidence of individually acquired habits in man becoming instinctive through heredity. Natural selection becomes more and more subordinate in the social evolution of civilized mankind; and it would seem probable that with this waning of the influence of

natural selection there has been a diminution also of human faculty. Hence there is little or no evidence of the hereditary transmission of increments of faculty due to continued and persistent use. A discussion of heredity in man thus confirms the inference drawn from the study of habit and instinct in some of the lower animals."

Those who disagree with any of these conclusions are invited to study carefully the strong arguments by which they are supported.

Further discussion of many of the interesting questions raised in this valuable work would have been desirable, but the limits of space forbid. Enough has been said, however, to show that this book compels the serious attention of all who profess to feel an interest in the instincts and habits of animals.

The printing and general get-up of the volume leave nothing to be desired. There is one excellent plate forming the frontispiece, representing a group of the young birds employed in the recorded observations, drawn by G. E. Lodge. E. B. P.

TRAVELS IN INDO-CHINA.

From Tonkin to India by the Sources of the Irawadi. By Prince Henri d'Orléans. Translated by Hamley Bent, M.A. Illustrated by G. Vuillier. Pp. xii + 467. (London: Methuen, 1898.)

FROM the time of the great expedition under Doudart de Lagrée, which in 1866-68 threw such a flood of light on the countries watered by the great Mekong River, and of which the story was so admirably told by the lamented Francis Garnier, the exploration of the eastern half of Indo-China has fallen almost entirely to Frenchmen, who with untiring energy have traversed its jungles, and by their successful enterprise have added an empire to the dominions of the French Republic. But in spite of the labours of these devoted pioneers, and of the equally zealous explorers who, from the British side, have sought to disclose the mysteries of that long-closed region, there still remained an inner recess, as it were, to which no European had succeeded in penetrating. The region in question had for many reasons possessed a singular fascination for geographers. Traversed, to use the words of the late Sir H. Yule, by "that formidable fascis of great rivers, descending from the highlands of Tibet, which give to the map of this region an aspect so unique in geography," it engaged attention not only from the various problems connected with the courses of those rivers, but from the remarkable barrier which it placed in the way of communication between the neighbouring countries of India (Assam) and China, a barrier so effectual that the same high authority, writing in 1883, could adduce only three instances in which it had been pierced during our own times, even by a piece of intelligence. It was reserved for Prince Henri d'Orléans, who had already made himself known by several enterprising journeys, to be the first to cross this barrier, in company with MM. Roux and Briffaud, and his lately-published narrative may be said without hesitation to have fully deserved the honours of a translation, such as is now before us.

Prince Henri's journey naturally falls into three sections, the interest of which may be said to stand in an ascending ratio. In the first, a little-known region lying on the borders of Southern Yunnan and Tonkin was traversed from east to west, the route terminating at the interesting Chinese town of Sumao, famous as the centre of distribution of the so-called "Puerh" tea, grown in the Shan country to the south. The second, of which the direction was mainly from south to north, was concerned with the exploration of a section of the Mekong, for a knowledge of which we were previously dependent solely on old Chinese maps, with the one exception of the crossing-point of the road from Burma to Yunnan. The river was struck at a point somewhat to the north of Kiang (or Xieng) Hung,[1] reached from Maulmein by McLeod in 1836, and likewise the last point at which the river was seen by Lagrée and his companions. From here, with the exception of a detour to Tali-fu and a minor deviation into the neighbouring Salwen basin, the valley of the Mekong was followed as far as the French mission stations in South-eastern Tibet, through the countries of the Lamasjens, Lissus, and other wild and imperfectly known tribes. The third and last section, in which the westerly direction was resumed, led across the previously unpierced barrier between China and Assam, the region of the Irawadi head streams, the system of which had been previously the subject of so much controversy among geographers. The starting-point for this section was the mission station of Tseku, the furthest point reached by Mr. T. T. Cooper, when he, too, nearly thirty years ago, made his first daring attempt to traverse the same, then impenetrable barrier.

The country traversed by this route was of such a character as to try the mettle of the hardiest of explorers. The great rivers, as is well known, flow in parallel courses, separated by steep mountain ranges, up which the traveller must climb by the most difficult of paths, which often run sheer above the foaming torrent rushing many hundred feet below him. The Prince's party were provided with a caravan of mules, and even these sure-footed beasts would occasionally lose their footing and roll down the steep mountain-side. They seem also to have had a propensity to stray, which entailed many an arduous search.[2] No less arduous were the marches through the trackless, dripping forests of the Upper Irawadi basin. The crossing of the rivers, too, often involved serious difficulties. The Mekong is provided in places with iron chain-bridges, the vibration of which demanded a steady nerve in the crossing; but this was nothing to the actual danger involved by the passage of rushing streams on frail rafts or by slippery bamboo bridges, or those consisting, after the Tibetan fashion, of a mere rope, down which the passenger shoots with lightning rapidity. The trusty interpreter Joseph, a convert of the missionaries at Tali, who, with his non-

[1] Prince Henri is in error in saying that a railway is in course of construction to Kiang Hung from Mandalay. Although schemes have been set on foot for the reaching of this place by railway from Siam and Lower Burma, the railway from Mandalay is to make for the Kunlon ferry across the Salwen, and to reach the Chinese frontier through the state of Kokang, lately ceded to Great Britain.

[2] A strange kind of fodder, given to them by the drivers, on the recommendation of the Tibetans, was a hash of raw fowls and salt, said to be a rare pick-me-up for beasts of burden.

descript Latin (his only medium of communication with the travellers), supplies many humorous touches, "loved not water frolics," and would utter a fervent *Deo gratias* when the danger was safely past. This man proved a valued and faithful servant, and, sharing all the dangers and vicissitudes of the way, was finally regarded rather in the light of a friend than a dependent.

Apart from the surface forms, the vegetation offered much of interest to the explorers, and its varied aspects —from the tropical forests of the lower valleys, to the woods of superb coniferæ on the mountain slopes, and the alpine flowers of the higher passes—are brought vividly before us as we read the Prince's pages, which describe some charming scenes. We read, *e.g.*, of cool forests "where white dog-roses scaled the trees and drooped in fragrant clusters over dazzling diadems of lilies of the height of a man, and under foot pink primulas made a gay carpet." Much valuable information is given, too, with respect to the aboriginal tribes above alluded to, as well as the Lolos of the extreme south of Yunnan, of whose manuscripts a fair number were obtained. Several specimens of the hieroglyphic writing of the Mossos on the Tibetan border were also procured, and the meaning of some of them, hitherto obscure, was explained by the magicians by whom the books are made. The Mossos and the Lolos are said to have probably had the same origin, belonging to the Tibeto-Burmese family; the Lissus also speak a dialect resembling that of the Lolos. Among the Minchias and Lissus some individuals seemed to have little in common with the yellow race, and one Lissu woman reminded Prince Henri of Russian gipsies. Vocabularies of the anguages of all these tribes are given in an appendix; but we do not find any comprehensive summary of their affinities, which would have been of much value.

A word must be devoted to the illustrations, with which the book is liberally provided. Their authority is not stated in the English edition, but from the French title-page we learn that they are from the author's photographs. It is doubtful, however, whether the artist has not in many cases allowed himself considerable freedom in their reproduction, especially in the somewhat sensational incidents represented. The translation is, on the whole, excellent; but a few errors of the French edition with regard to proper names have been retained. Thus we find Rochill for Rockhill, likewise Bonnin, Manhat, Néris, and Aymard, presumably for Bonin, Mouhot, Neis, and Aymara, which shows the need of revision by one acquainted with the subject treated. For English readers the French spelling of geographical names should have been modified. It requires an appreciable amount of time to recognise the pronunciation of some in their unfamiliar garb, as, *e.g.*, when In-shwan is written In-chouan. According to the prevailing French fashion the spelling Thibet is retained. This has, it is true, the authority of M. Desgodins, but others of his countrymen have held the *h* to be incorrect, or at least unnecessary. (Cf. *Comptes rendus*, Paris Geographical Society, 1887, *passim*.)

Taken as a whole, however, the book forms a worthy record of an important journey, and the interest of the narrative is well sustained from beginning to end.

INJURIOUS INSECTS DURING 1897.

Report of Observations of Injurious Insects and Common Farm Pests during the Year 1897, *&c.* By Eleanor A. Ormerod. Pp. viii + 160. (London: Simpkin, Marshall, and Co., Ltd., 1898.)

THE publication of this, the twenty-first of these annual reports, will prove, as heretofore, welcome both to agriculturists—for whom primarily they are intended—and to those interested in a public-spirited and isolated attempt to grapple seriously with problems of State entomology in this country.

Of insect attacks to field crops during 1897, no cases of the first importance are recorded; the Cabbage-aphis (*Aphis brassicæ*) and Silver Y-moth (*Plusia gamma*) were locally destructive, the latter to mangolds in Co. Kerry, and attack of the Diamond-back moth (*Plutella cruciferarum*) on turnips was again reported, this time from various spots on the east and west coasts of Scotland. As has so often been the case of late years, nematode disease of oats and clover was troublesome.

During the last few years the strawberry crop has suffered badly from two species of ground-beetles, *Harpalus ruficornis* and *Pterostichus vulgaris*, which have acquired the habit, singular in carnivorous insects, of feeding on the unripe and ripe fruit. The infestation has occurred in several counties, ranging from Nottinghamshire and Hertfordshire to Gloucestershire, and causes much loss and anxiety to growers. No satisfactory mode of prevention is known, and recourse is generally had to methods of trapping the imagos. Evidently, the breeding habits and mode of life in the larval stage should be more fully studied; the suggestion, sometimes made, that the insects are conveyed with manure, is somewhat improbable, and needs proof.

In 1889, much interest was aroused among entomologists by the attacks on plum-trees of a Scolytid beetle, *Xyleborus dispar*, previously a very rare species in Britain. Curiously enough, Miss Ormerod now records a severe infestation of the same orchards by a second species, *X. xylographus* (*saxeseni*). The subject is dealt with at length, but without fully establishing the culpability of *X. xylographus*, itself rather a scarce species in England, and one not usually associated with injury to healthy trees. *X. dispar* was also present in small numbers, and the coexistence of these species, so often found in association on the continent, may point to a possible importation. These attacks deserve further careful study; the relationship between Scolytid infestation and the health of the host-plant, however obscure, should never be disregarded or minimised, and the author's singular statement, that she knows of no difference between the perforations in trees made by each species, proves that their respective shares have not been properly evaluated.

Amongst other enemies to trees, *Cryptococcus fagi* has proved very injurious to beech at Burton-on-Trent. Common as it is, it is seldom so markedly destructive. Treatment is difficult, as insecticide dressings cannot always be profitably employed on trees of so large a size.

The report contains articles on several granary insects, including the Angoumois moth, *Sitotroga cerealella*, which

is probably often imported in grain, without establishing itself permanently in the country; and among subjects of minor importance, cockroaches, earwigs, and the like, may be noted the importation of dead locusts in some numbers in fodder from the Argentine Republic. There is evidence that their consumption has caused injury to horses, perhaps through mechanical irritation. Needless to say, Miss Ormerod does not encourage the idea that the introduction of live locusts, which in small numbers is almost an annual occurrence, is likely to cause an invasion.

It must, we imagine, be a source of regret to the author that the example she sets does not lead to a more thorough study of our insect pests. In many cases, the good that can be done by a referee, restricted as to opportunities for field observation, and depending largely on the capacity and good-will of correspondents, soon reaches a limit, which requires to be extended by broader methods of inquiry on the lines which have been so well developed in the United States. And it is satisfactory to note that the economic treatment of that very troublesome pest, the Currant Gallmite, discussed in a special appendix, is now being made the subject of extended research at the Woburn Experimental Fruit Farm. W. F. H. B.

OUR BOOK SHELF.

Elements of Comparative Zoology. By J. S. Kingsley, S.D., Professor of Zoology in Tufts College. Pp. 344, small 8vo.; with 148 illustrations. (New York: H. Holt and Co., 1897.)

THE reputation of the author of this little book justifies the expectation of novelty, and in this we are not disappointed. The work, which has a local flavour, is based upon a conviction expressed in the preface, that while "laboratory guides are somewhat numerous . . . general outlines of zoology adapted to beginners are few," and that "nature studies are truly educational only when the student is trained to correlate and classify facts." Imparting a knowledge of the zoological alphabet by the now universally adopted Huxleyian method, the author proceeds to supplement that by a sort of reading lesson, in the form of a very brief outline of some of the chief structural limitations and ordinal characters of each group of which a typical species has been previously more fully examined, leading thus up to class distinction and the definition of phyla. In this manner the gnathostomatous vertebrata are first taken in hand in ascending order, and next the invertebrata in descending; and after a short chapter on each of the great animal sub-kingdoms, the work concludes with others on the metazoa, protozoa, comparative physiology, morphology, and on the animal kingdom. The practical mode of elementary instruction in biology by the type-system was never intended to go unsupplemented; and while the plan here adopted is one which must have been elsewhere in vogue, as the natural result of the growth of the system, to the author is due the credit of having first developed it in print. His chief novelty lies in the substitution of an interrogatory for the time-honoured didactic mode of treatment of the practical portion of the subject, with the introduction of a series of "Comparisons" in the form of questions which make for correlation of ideas. A very ingenious departure! but we would rather await the verdict of time upon it than pronounce outright. Fair consideration is given to habit, distribution, and other topics where desirable; and the book, though thin, is on the whole trustworthy and fairly up to date, its weakest part being the physiological, the few short pages devoted to which are hackneyed and behind the times. A goodly amount of sound advice is scattered throughout the introduction and the text. The illustrations are very unequal, Fig. 63 being a positive burlesque on nature, Fig. 25 antiquated and useless, and Fig. 69 erroneous, by lack of knowledge of the large series of observations finding their focus in Boas's discovery of a prepulmonary aortic arch in the frog's tadpole. As leading error may be cited the allegation concerning the function of the marsupial bones, and as ill-advised the adoption of the Hæckelian classification of birds. In formulating so common-place a system as the dental of the dogs, the author has gone astray; and special interest attaches to the remark that he, an American, should write of the Ruminantia Cavicornia that their "horns are never shed," and give, in illustration of this assertion, a picture of the American Prongbuck, notorious as the only exception to that rule! We would recommend the consideration to the zoological brotherhood.

The Tutorial Chemistry. Part ii. *Metals.* By G. H. Bailey. Pp. 300. (London: W. B. Clive, 1897.)

THE present volume is intended to supply the student with his second year's course of study, the first year having presumably been spent over the "non-metals." The first section, occupying about one-third of the book, deals with chemical physics, the remainder being taken up with the systematic description of the commoner metals. There are three appendices, dealing with crystallography, spectrum analysis, and some suggested experiments. The section on chemical physics commences with a description of the methods available for the determination of atomic weights, this being followed by a discussion of the relations existing between the numbers thus found and the physical properties of the elements. Chapters iv. and v. deal with dissociation, specific volume, and the optical properties of liquids. The chapter on solution is the largest in the section; but the treatment of this important branch of the subject is not so satisfactory as that of the other portions dealing with physical chemistry. Thus, while a considerable amount of space is devoted to the hypothesis of Grotthus, which the student will afterwards have to unlearn, the work of Hittorf is not mentioned, although the latter forms the keystone of the modern theory of solution.

In spite of the great compression necessary, only 150 pages being allotted to a description of some fifty elements, the latter portion of the book gives a clear and concise account of the preparation and properties of the metals, each group being preceded by a summary of the reactions common to its constituents.

The classification of Mendeléeff is adopted throughout; and since the clear exposition of the periodic law requires the inclusion of certain of the "rare" metals, such elements as gallium, indium, thallium and uranium are described in their proper places along with commoner elements, instead of being relegated to a kind of museum of curiosities in the form of an appendix—a practice unfortunately usual with the smaller text-books.

The Kingdom of the Yellow Robe: being Sketches of the Domestic and Religious Rites and Ceremonies of the Siamese. By Ernest Young; with illustrations by E. A. Norbury. Demy 8vo. Pp. xiv + 399. (Westminster: Archibald Constable and Co., 1898.)

THE author has had the advantage of several years' residence in Siam, during which time he learned the language, and his educational duties enabled him to observe the working of the native mind. He writes with an evident sympathy for the common people; and in his sketches of the every-day life of the capital, he has caught not a little of the humour which is one of its chief characteristics. He discourses pleasantly on

street and canal scenes, and explains at some length many of the more important ceremonies by means of which Siamese Buddhists make the amount of "merit" necessary for the bettering of their position hereafter, and he gives a short account of the Buddhism of the country. The author makes some interesting observations on education, and gives an attractive picture of the children with whom his duties brought him in contact. He does not go far beyond the capital, and the scattered remarks about the interior do not enlighten the reader much as to the commercial aspects of the country. Politics have also been rigorously excluded. On the whole there is not much which may not be found in Turpin, Crawfurd, Bowring, or Alabaster, or in the recent writings of Captain Gerini. The author does not, however, pretend to an entirely original or exhaustive treatment of the subject. His aim has rather been a chatty and popular account of the life and ideas of the ordinary people, as they present themselves to the observant resident of Bangkok. The Far East is daily coming nearer, and becoming more intelligible, to the Western reader, and the present work is one which, in our opinion, distinctly helps to bridge the gulf which yet lies between them.

The illustrations, which, it is no discredit to the author to say, form the chief feature of the book, are by Mr. Norbury, another old Bangkok resident. Some of these, especially the full-page drawings towards the end of the book, are quite charming, and give some characteristic scenes with a rare combination of fidelity and artistic effect.

The West Australian Settler's Guide and Farmer's Handbook. (Perth, W.A.: Wigg and Son, 1897-98.)

WEST Australia is at the present time best known to us by its gold mines; the real importance of this vast and almost unoccupied territory must, however, be determined by its capability of supporting in the future a large population, and hence the agricultural capabilities of the country become an extremely important factor in any schemes for its development. The Handbook before us is issued by the Agricultural Department of the Colony; its object is to present a picture of the agricultural capabilities of various districts, and to advise intending settlers as to their best course of action. It deals chiefly with the south-western portion of the Colony, a district enjoying a better and more uniform rainfall than is generally met with in Australia, and the general fertility of which is vouched for by the occurrence of large areas of heavily-timbered land. The forests of West Australia are said to occupy more than forty million acres; the wood from them has already been employed in paving London streets. Large areas of the country appear to be especially adapted for vine culture. Part i. of the Handbook describes the agricultural areas open for selection. Part ii. contains general instructions for settlers. Part iii. deals with the natural grasses and weeds, and with various imported crops. Part iv. is devoted to sheep husbandry. Part v. is a general treatise on soils and manures, without much special reference to Australia. The whole publication is freely illustrated. The photographs of the forest trees are very striking. The maps are bad, and quite insufficient for the purpose. The Handbook has evidently been hastily put together, and its value is often marred by the want of a clear arrangement of the subjects discussed. R. W.

Die Gattung Cyclamen *L. eine systematische und biologische Monographie.* By Dr. F. Hildebrand. Pp. 190, with 6 plates. (Jena: Gustav Fischer, 1898.)

LIVING plants have served Dr. Hildebrand as the basis of his careful study of the genus *Cyclamen*, and herbaria have afforded additional material. The result is a most thorough monograph of the genus, the thirteen species of which have been studied in great minuteness. Eighty pages are given to the description of these, and the remaining portion to a general review of the genus. The book is extraordinarily free from theory; indeed, it is a storehouse of facts.

One species of this genus, *C. persicum*, has recently been brought forward as affording a good instance of the gradual accumulation of small variations, which has yielded the many forms in cultivation. For this reason it has a special interest; and Dr. Hildebrand's assertion of the variability of the wild plants (p. 166), and his recognition of no hybridisation of this species, come as opportune remarks. Variation in the leaf has particularly attracted the author's attention; and he notices, too, that there can be traced no connection (p. 172) between the variability of the foliar and floral organs.

Of biological interest are such statements as the following: that the corms have for a protection some poisonous substance (p. 92); that the leaves have no character in them which will definitely support Stahl's theory of the relation of their shape to rainfall (p. 110); that the pollen, at first sticky, becomes dry and powdery (p. 132); that ants appear to aid in the dispersal of the seeds (p. 142); and that the corm begins to form very early in germination (p. 11). From these the general trend of the book may be judged; but, in addition, anatomy, teratology, distribution, and the relation of the species to their habitat, the rest of the seed, age of the plant at flowering, colour of the leaves, &c., find a place. The whole results in a most careful work, which, unfortunately, wants a good index. I. H. B.

An Arithmetic for Schools. By S. L. Loney, M.A. (London: Macmillan and Co., Ltd., 1898.)

THIS is a comprehensive text-book clearly written and well arranged. There is a useful chapter on abridged methods and approximations, and a note (in the appendix) on the metric system. Compound interest is, very properly, done entirely by decimals. The examples are numerous, sensibly chosen, and carefully graduated. The term "concrete number" is objectionable; so is the statement "1 lb. of sugar = 2*d.*" in the explanation of the chain rule. In compound proportion too much of the old-fashioned paraphernalia has been retained; and we think that too much attention has been paid to the conversion of vulgar fractions into recurring decimals, and *vice versâ*. It would be a good thing if recurring decimals could be eliminated from all elementary examinations in arithmetic; they are of no practical use, and the tiresome calculations connected with them help to perpetuate the English prejudice against the metric system. It may be worth noticing that in Chapter v. the term "power" and the index notation are apparently introduced without previous explanation. In some cases it would be well to give not only an explanatory working of an example, but also the actual computation, arranged in proper form. It is true that this is done in many cases; but there are many others where the working is decidedly clumsy, owing to the addition of explanatory matter. On the whole it may be said that this work, while not specially distinguished by novelty of treatment, deserves to rank with the best of its class. G. B. M.

Navigazione Aerea. By Guglielmo N. Da Pra. Pp. 73, with 18 woodcuts and 6 plates. (Milan: Ulrico Hoepli, 1898.)

THIS is a critical examination of the various conditions which must be satisfied by a flying machine, together with designs of proposed arrangements of aeroplanes to be worked by means of benzene motors symmetrically arranged.

On the principle that "an ounce of practice is worth a pound of theory," it will be interesting to see how far Signor Da Pra's predictions as to the form of the flying machine of the future are confirmed by future experiments. G. H. B.

Lessons with Plants. By L. H. Bailey. Pp. xxxi + 491. (London: Macmillan and Co., Ltd., 1898.)

THOUGH written for the use of teachers and students of botany in North America, this book will be found almost as useful on this side of the Atlantic. Very many of the plants employed as examples are either natives of, or very generally cultivated in, the British Islands, and could easily be obtained both in country and in town. Even where the selected examples are not themselves readily procured among us the methods of study, the lessons drawn from them, and the suggestions offered for further personal investigation, are very often such as could be readily applied by an intelligent reader to British species.

The author very consistently carries out his method of instruction. He assumes that the pupil is absolutely ignorant; and taking familiar objects, such as an apple-twig, he shows simply and well the information that can be read in them by the trained eye and mind. The book is admirably fitted to give training in the methods of observation, in so far as that can be given during school-life. It should be of peculiar value to teachers if used (as the author, in the introduction, points out that it is meant to be) to suggest how lessons can be drawn from any and every plant. One cannot read many pages without realising that the careful observation and accurate knowledge gained by the teacher that works out examples in the manner followed here will enable him to make the subjects taught by him very real and living. It is the true scientific method applied to the first steps in botany. To the beginner in the science, also, who wishes to learn, but cannot obtain systematic instruction, this book would be an excellent introduction. If each section were read with the actual specimens in hand, and compared with the description step by step, and, still more, if the "suggestions" were followed out practically, the student would have gained a very valuable training, and a trustworthy foundation on which to build up the wider study. The method followed is naturally somewhat informal; but it allows of many sides and applications of botany being touched on in a way to awaken the interest of pupils; and the information conveyed is of a kind that does not require to be unlearned, but can be built up into its proper place as the study becomes more systematic. Occasionally one feels that the explanation is insufficient, and that it must leave a vagueness in the mind of a beginner, as, for example, where we are told that it is "the custom of botanists" to "say that when either floral envelope is wanting it is the corolla (unless there is some special reason to the contrary). This is, generally, an arbitrary definition, but it would be just as arbitrary to say that the sepals are missing." It is scarcely "evident" in respect of the ligulate flowers of the dandelion and Rudbeckia "that if the corolla of a floret were to develop to such a length, it could not spread equally in all directions, as a mathematical calculation will prove; it therefore develops in one direction, as a leaf does." The description of the flowering spurge would scarcely be clear to a beginner. But such defects are so inconspicuous as to detract little from the value of the book, which is enhanced by many excellent original "delineations from nature."

Ethnological Studies among the North-West Central Queensland Aborigines. By Walter E. Roth. Pp. xvi + 199, and Plates. (Brisbane: Gregory, 1897.)

THE chief difficulty which an investigator has to surmount in studying the habits and customs of a savage race is their innate suspicion, which often prevents them relating not only the traditions of their tribe, but also their common customs.

Roth claims to have overcome this difficulty by a prolonged residence among the natives of North-West Central Queensland, and states that it was not until he was fully conversant with their language that he could acquire sufficient confidence from the natives to learn their customs.

As an aid to future explorers, he begins his book with an elementary grammar and vocabulary of the language spoken in the Boulia district: a table is added, comparing the words in common use in adjacent districts.

This race communicates ideas by signs as well as sounds; the origin of the actual manual movements is usually easy to trace, and lucidity is added to the description by illustrations. Social and individual nomenclature among these races is developed to such an extent, that careful study of an admirable chapter devoted to the question is necessary for the reader to fully comprehend that intricate organisation.

Roth describes the food and the method of obtaining and preparing it; the recreations and amusements of the people. Cannibalism, he states, is practised in the Boulia district; but a person is never slain for the purpose of supplying food, nor may any but relatives partake of a corpse.

The last chapter is devoted to descriptions of initiation ceremonies, which are often too gruesome to dwell upon in detail. The book consists of a description of a number of facts; the origin and development of customs is but rarely attempted.

L'Électro-chimie. Production électrolytique des Composés chimique. By A. Minet. Pp. 167. (Paris: Gauthier-Villars et Fils; Masson & Cie.)

THIS little work is a volume of the well-known "Encyclopédie Scientifique des Aide-Memoire," and is devoted mainly to the industrial applications of electrolysis other than those of which the object is the preparation of metals. The chapter dealing with the electrolysis of solutions of sodium and potassium chlorides, which gives a good account of the more important processes which have been proposed for the preparation of caustic alkalis, hypochlorites and chlorates, may be specially commended. The attempts which have been made to employ electrolysis in purifying and ageing alcoholic liquids, in tanning, and in purifying sugar, are described, as well as a number of minor applications of the electric current.

"Théories de L'Électrolyse" (pp. 175) is another volume of the same series as the above, and by the same author. It gives a sketch of the theory of the voltaic cell, of the constitution of electrolytes and gases, and of osmotic pressure. Electrolytic conductivity and the migration of the ions are also treated at some length. The researches of the author's fellow countrymen are rather fully, though not always clearly, described, the work done in other countries receiving very inadequate treatment.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Malformed Crabs.

IN your issue of March 10 I observe a most interesting letter from your correspondent, Mr. R. I. Pocock, regarding a malformed specimen of *Cancer pagurus* in the Dover Museum. I have never seen such a remarkable case of malformation in the common edible crab, but in the Robertson Museum here is to be seen a very fine specimen of *Nephrops norvegicus*, having three digits on the right pincer or great claw. The supernumerary digit,

which is fully two-thirds the size of the normal one, springs from the inner side of the base of the inner movable finger, and is sharply toothed on both sides, and directly opposable to the outer finger. The normal digit is fully developed and curves outwards from the supernumerary one at a wide angle, the distance between them being fully three-quarters of an inch at the points. They move together, and permit an opening of about half an inch between the supernumerary and the normal outer digit, so that little or no inconvenience would be caused to the animal during life. This specimen was caught by fishermen in the neighbourhood of Cumbrae, and was given to a Millport gentleman, Mr. Liddle, who kindly handed it over to the Museum.

ALEXANDER GRAY.

Millport Marine Biological Station, March 6.

SCIENTIFIC EXPERTS AND PATENT CASES.

WE have often had occasion to point out the many disadvantages which are connected with the present system of obtaining and using scientific evidence in courts of law. The disadvantage which chiefly concerns us is that science and men of science are at times thereby drawn into and through mud of a most objectionable quality; but there are many others.

We are glad to see that the matter has again been brought to the front, and this time by the Lord Chancellor himself, and that alterations in the present mode of procedure are being discussed.

We content ourselves this week by reproducing the following leading article in Wednesday's *Times*:—

In the recent sittings of the Law Courts nothing has been more remarkable than the large number of patent actions. Certain inventions have been veritable gold mines to patent lawyers, agents and experts. The bicycle is scarcely more familiar in the streets and highways than in the Courts. We could name patentees who are never out of litigation to protect their menaced rights; certain lamps, gas burners, and explosives are always "going to the Lords." A very substantial part of judicial time is taken up in examining the rival claims of inventors, and they are likely to ask for more. The history of science is constantly illustrating the fact that the same ideas are in many minds at the same time, that often it is an accident whether A or B first propounds his suggestions, and that the priority of one over the other may be a matter of a few months or even days. That is a partial explanation of the multitude of disputes as to bicycle tires, bicycle saddles, metal rims, chains, and gear of all sorts. A further explanation is to be found in the profits derivable from patents as to articles used by hundreds of thousands. Sometimes the Courts are called upon to decide between two independent inventors. Just as often the fight is between one who has an honest claim and another who wishes to levy blackmail or to be bought out. The mode of determining such actions is far from satisfactory. The Lord Chancellor, in a case in the House of Lords which we reported the other day, gave expression to a widespread opinion on this point. The case turned on five or six lines in a specification relating to the tires of bicycles; but it occupied inordinate time both in the Court below and in the Court of Appeal. "Having regard to the extravagant and extraordinary consumption of time which was involved in the determination of this case," said the Lord Chancellor, "witnesses of great eminence being called upon both sides and evidence given which amounts in the book which I hold in my hand to 500 printed quarto pages, it is no wonder that, if a case so simple in its character is so protracted, there is what is called a 'block' in the Courts of law." So serious is the state of things that the Lord Chancellor intimated that it might be necessary to hand over to a special tribunal the trial of cases for which the ordinary procedure seemed inapt. A well-informed correspondent, Mr. W. L. Wise, in a letter which we publish to-day, expresses much the same opinion in even stronger terms. "The present state of things virtually amounts to a denial of justice to all but those having the command of large sums of money." This is an old complaint. Years ago the late Master of the Rolls said, "There is something catching in patent cases, which is that it makes everybody argue and ask questions to an interminable extent. A patent case, with no more difficult question to try than any other case, instead of lasting six hours, is invariably made to last six days, if not twelve. I am sure there ought to be some remedy for it." In Ehrlich *v.* Ihlee" the Court of Appeal took occasion to complain of the "frightful mischief" caused by the prolixity of the proceedings in patent actions. Mr. Wise suggests a remedy. He points out that the Comptroller-General of Patents or his deputy determines questions not unlike the questions of infringement which come before the Courts; and he trusts that, if the staff of the Patent Office were strengthened, a tribunal more economical, expeditious, and not less fit than the present would be found. An appeal lies to the law officers; and it is a recommendation to the suggested system, in the eyes of our correspondent, that at all stages patent agents may appear for the parties.

We have our doubts about the efficacy or success of this recommendation, though certainly not on the ground that patent agents, whom the Legislature has very properly recognised, would have a larger field than is now theirs. We should be glad to see them invested with more privileges, and corresponding responsibilities when they proved ignorant and careless. But such a tribunal would not satisfy patentees, who are the most pugnacious and persevering of litigants. Beaten in one Court, they will resort to another; if they at last acquiesce in the decision of the House of Lords, it is only because there is no tribunal above it. Such are the uncertainties necessarily attending many of the disputes, and, above all, such are the rewards that come with success in patent actions, that every weapon is, and always will be, used in the fight. It is not to be expected that, to take two examples at random, the parties to the litigation before Mr. Justice Wills in 1896 and 1897 in "The Incandescent Gas Light Company *v.* the De Mare Incandescent Gas Light System" and "The Pneumatic Tyre Company *v.* the Ixion Pneumatic Tyre Company" would be content with the decision of a few officials of the Patent Office. In the great majority of the cases referred to by the Lord Chancellor and by our correspondent much money is at stake; and the parties will spare no expense to gain their point.

A more plausible suggestion is that the evidence should not be left, as it now is, solely to the discretion of the parties; that the Judge should nominate some experts—if possible one in whom all have confidence—to report on the invention and the question of novelty, validity, or infringement; and that he should be guided by the report unless it was shown to be erroneous. This would prevent the competition, so common and so ruinous to poor litigants, in the production of expert evidence. It is no small recommendation of this suggestion that under other systems of law it is adopted and is found to answer. There is, however, some force in one criticism—Where, in many cases, is a truly impartial expert to be found? If the question is one of great importance, a scientific witness of eminence has probably in his writings or in some discussion committed himself, directly or indirectly, to an opinion on one or more of the points involved. To take an actual instance, it would have been difficult in the recent litigation between the Maxim-Nordenfelt Company and Sir William Anderson to have found a chemist whose report on the properties of the explosives under consideration would have been accepted as *prima facie* valid. Good might come of a special tribunal framed on the lines of the Commercial Court. But sometimes what is imperatively needed is the unbiased opinion of an intelligent outsider with no theories about physics. One point of delicacy is rarely touched by the critics of the existing system. It must be present to them all. In some professions a traditional sense of honour prevails to which all must conform, or appear to do so, and which prevents open and flagrant deviations from rectitude. Among doctors, for example, there are black sheep; but they keep well out of sight. It is notorious that, even in cases in which life and death are at stake, or when there happens to be a temptation to speak loosely, it is rare to find a doctor giving evidence in favour of theories which his brethren would scout as manifestly absurd. Could as much be said of the testimony of scientific experts in patent actions? There may be countries in which such witnesses never overstate the case and never sell their opinion. Ours is not one of them. Many scientific witnesses who ought to know better have acquired a very bad habit; they have come to regard themselves as advocates—in the witness-box. It seems a poor palliation of a real evil to press on scientific experts—some do not need that counsel—a loftier notion of their function than befogging the Judge or finding more or less plausible reasons for what they know to be untenable and absurd.

PHOTOGRAPHIC SURVEYING.

FIFTY years ago or more, M. Beautemps Beaupré successfully employed a process which greatly facilitated the work of surveying, and which in its modern developments is likely to supersede the tedious work of measurement in the field. Where the greatest accuracy was not required, the method recommended itself on account of its great practical utility, enabling contoured maps to be produced without the labour of heavy calculations. M. Beaupré availed himself of the principle of the camera lucida, and by its aid sketched the panorama about him from two ends of a measured base line. In a paper recently communicated by Prof. E. J. Mills to the Institution of Engineers and Shipbuilders in Scotland, it is contended that the best work is still done when this principle is utilised. From two views taken at a known distance from each other, however procured, one is able to plot a map with a fair amount of accuracy, and knowing the correct relative distances of the objects their vertical height can be deduced. No doubt there were difficulties in the application of the method. Any one who has attempted to draw a picture of a distant object by means of Wollaston's invention knows that the result is apt to be a little disappointing, though successive improvements in the mechanism have removed many of the effects arising from parallax, which interfered with correct delineation in the early days when the instrument was first used. But the process still remains long and tedious, and it was inevitable that the introduction of photography with its rapid and accurate results, should be welcomed as likely to banish the slow methods of hand drawing in the initial stages of the work.

To obtain a photograph which should be free from optical distortion, and to which the laws of geometrical perspective could be applied without any correction, has not been an easy task. But now it may be said that we do possess lenses which will cover an angular field of about 60° without measurable distortion, and give uniform definition all over the plate. Enlargements and printing from the original negatives doubtless still present some difficulties. Prof. Mills, we notice, recommends that the prints should be made on bromide paper, and developed with amidol. Shrinkage and distortion of the paper will, it is asserted, be prevented, when soaked in a two per cent. solution of formalin, and dried at a gentle heat. Other authorities, however, distrust paper altogether, and prefer to use a bromide emulsion on opaque or translucent plates of flat glass as likely to give less error. But the possession of accurate optical arrangements, combined with exact manuipulation of the photographic result, suggests many new applications to which the camera can be profitably applied, and the surveyor now finds himself equipped with an instrument of scientific precision, in which are combined the main features of a theodolite and a level, and which replaces the plane table and its accessories.

In the earliest form of surveying camera or photogrammeter, to give it a polysyllabic title, the instrument consisted of little more than an ordinary bellows camera, set on a horizontal circle, and moving about a vertical axis. The distance between the plate and the lens was fixed, and the camera could be levelled by means of screws in the head of a tripod in much the same way that a theodolite is adjusted. In the subsequent development and increased effectiveness that have been added to this surveying instrument, two names stand out prominently, that of Colonel Laussedat, the present Directeur of the Conservatoire des Arts et Metiers, Paris; and in this country that of Mr. Bridges Lee. In the French form, the camera is placed on the top of a stand carrying a transit theodolite, and the disposition of the several parts is arranged to ensure stability and symmetry about a vertical axis, while each part of the instrument can be used separately. In the English form, Mr. Bridges Lee has wisely determined that while each photograph should offer a correct perspective view of the country it represents, it should also carry on its face the information necessary for the correct interpretation of the picture, and the subsequent construction of a map. When passing through countries where roads are scarce and travelling difficult, notebooks are apt to be lost; but without more words, every one must appreciate the arrangement by which the "constants of reduction" are made as permanent as the picture to which they refer.

The general principles on which the Bridges Lee camera has been constructed, and the objects sought to be attained, have already been briefly explained in these columns (vol. li. p. 191). Its present form has been adopted because experiment has proved the necessity of great nicety of mechanical adjustment to obtain the best results. To ensure the necessary lightness and rigidity, the camera box is made of aluminium. The direction in which the instrument is pointed can be read off an azimuthal circle, graduated to minutes, on which the camera turns. A level on the top of the box ensures the horizontality of the instrument, and when this adjustment has been made, a telescope, also securely attached to the top of the camera, will move in a vertical plane through a sufficient range of angle for all ordinary terrestrial work. The angle through which the telescope can be moved in altitude is also read to minutes. This supplies the observer with a theodolite, and its position is so arranged with reference to the other parts of the instrument, that the line of collimation and the vertical wire of the theodolite are in the same plane with that which bisects the photographic lens. In this same vertical plane, a "wire" is fixed to the frame of the camera, cutting the optic axis of the lens at right angles, and consequently marks on the photograph the median vertical plane of the instrument. Another wire, also through the optic axis at right angles to this, will mark the horizon of the instrument on the picture, and the intersection of the two wires will give the "principal point" of the perspective. Inside the camera is placed a magnetic compass, and the scale being transparent, it is printed on the picture. The axis of rotation of this compass is in the same plane as the axis of collimation of the theodolite, and of the vertical wire. The distance between the scale of the compass and the vertical wire is kept constant by a device which works automatically when the camera is in use, and since this distance very slightly exceeds the radius of the compass, the wire can be used as a pointer to read the scale. One very important addition to the usefulness of the instrument is the insertion of a scale of angular distance, photographically prepared by the same lens as that fitted in the instrument when complete for surveying purposes. The scale is so attached to the frame, that it is photographed on every picture taken, and by its aid one can easily read off the angular distances of any point in the picture right or left of the median vertical plane.

A method of surveying in which the necessary observations are easily and rapidly collected, or are implicitly contained in a series of photographic views, has the promise of a large future. In travelling over unsettled districts, where it is impossible to remain for any length of time on a particular spot, the photographic method seems likely to supersede all others. Indeed no other method seems possible. Moreover, a photograph contains an amount of detailed information concerning the country photographed, which it is quite impossible to get from notes of observations and sketches, although much time may be spent in making these additions as carefully as possible. In this connection, one might call attention to the beautiful mountain maps which have been prepared for the German and Austrian Alpine Club

Here the work is based on the original ordnance survey maps, and the topographical details filled in from photography. These maps represent one of the most successful applications of photographic surveying. Again, in preliminary experimental surveys for irrigation purposes, or for deciding on the best route for a proposed railway, the camera, properly controlled, possesses many advantages over ordinary surveying instruments. In such cases it is often excessively difficult to determine beforehand how much plotting will be necessary to secure the object in view. The district may have to be re-visited over and over again to supply the requisite details, all of which may prove useless in the end. But with the photographic pictures secured by a camera, the plan may be plotted so far only as required, and if additional information be needed, the photographs can be made to give all the detail wanted without going again to the field. Irrigation surveys for agricultural purposes have been effected in the North-West Provinces with complete success by the photographic method, and are likely to be still further extended. Prof. Mills tried to apply the method to the determination of the content of a ship in dock by constructing a model of the vessel in clay, the necessary dimensions for which were to be taken from measured photographs. When the amount of clay in the model, and the scale of the photograph from which the necessary measurements have been taken are both known, the capacity of the ship is at once determined. In this particular instance, it is true, the method failed, owing to the impossibility of selecting suitable stations for the photographs amid the crowded machinery of a busy ship-building yard. But the attempt shows the wide applicability of the method and the extent of the field open to the intelligent use of photographic appliances.

But its greatest triumphs are, of course, to be seen when the method is continuously applied over a large area. One of the most successful operators is Mr. E. Deville, the Surveyor General of Dominion Lands, who has carried his investigations over the difficult passes of the Rocky Mountains, and surveyed the country up to the United States boundary of the Alaska territory. No less than 14,000 square miles of this inhospitable country were surveyed in the years 1893–94. The proper administration of the country, he tells us, required a tolerably accurate map, and means had to be found to execute it rapidly, and at a moderate cost. The ordinary methods of topographical surveying were too slow and expensive for the purpose; rapid surveys, based on triangulations, and sketches were tried and proved ineffectual; then photography was resorted to, with the result just mentioned. The same authority, as was natural to one in his official position, has made a very careful comparison of the relative expense of a survey made with the plane table and one with the camera: all such comparisons are liable to be modified by the climatic conditions of the country, and the amount of detailed plotting required. In the climate of the Rocky Mountains, Mr. Deville estimates that on one half of the number of days in a season, no work can be done with a camera, owing to smoke, fog, rain and snow storms. But quite as great a loss of time is experienced with the plane table, added to which the apparatus is more weighty, requiring more porterage, and therefore additional expense in removal. But neglecting these and some other slight advantages which are on the side of photography, he finds that the plane table survey is three times (rigorously as 164 : 56) more expensive than that accomplished by the camera. This is a real practical advantage which is immediately appreciated, and on several grounds, not taken into Mr. Deville's estimate, such as the possibility of reducing the number of highly-trained assistants, it would seem that the difference of expenditure has not been overestimated. There is no sacrifice of accuracy to secure this economy; the great improvement consists in the substitution of the methods of photography—methods, which proving highly popular, must tend to displace more and more the use of the plane table.

BALNIBARBIAN GLUMTRAP RHYME.

(Repeated by the children in the nurseries of Balnibarbi.)[1]

DISTANT scintillating star,
Shall I tell you what you are?
Nay, for I can merely know
What you were some years ago.

For, the rays that reach me here
May have left your photosphere
Ere the fight of Waterloo—
Ere the pterodactyl flew!

Many stars have passed away
Since your æther-shaking ray
On its lengthy journey sped—
So that you, perhaps, are dead!

Smashed in some tremendous war
With another mighty star—
You and all your planets just
Scattered into cosmic dust!

Strange, if you have vanished quite,
That we still behold your light,
Playing for so long a time
Some celestial pantomime!

But, supposing all is well,
What you're made of, can I tell?
Yes, 'twill be an easy task
If my spectroscope I ask.

There—your spectrum now is spread
Down from ultra-blue to red,
Crossed by dark metallic lines,
Of your cooler layer the signs.

Hence among the starry spheres
You've arrived at middle years—
You are fairly old and ripe,
Of our solid solar type.

Ah, your sodium line is seen
Strongly shifted towards the green.
Hence you are approaching me
With a huge velocity!

But, if some celestial woe
Overtook you long ago,
And to swift destruction hurled
Life on every living world,

Did there in the fiery tide
Perish much of pomp and pride—
Many emperors and kings,
Going to do awful things?

Mighty schemes of mighty czars—
Mighty armies, glorious wars!
From the Nebula they may
Rise to curse a world some day!

G. M. MINCHIN.

[1] Balnibarbi is one of the countries visited by Gulliver; the "Glumtrap" is the Balnibarbian equivalent of the English nursery; and the babies of Balnibarbi are brought up on strictly scientific principles—as is evidenced by their knowledge in these verses.

NOTES.

THE preliminary circular for the jubilee meeting of the American Association for the Advancement of Science to be held at Boston, August 22–27, has just been issued. Prof. Frederick W. Putnam, the president-elect, repeats the assurance given to the nominating committee at the last meeting, that this second Boston meeting, held on the fiftieth anniversary of the foundation of the Association, "gives promise of being the most important scientific gathering ever held in the United States." A special effort will be made to increase the membership, in the hope that at least one thousand new members will be added. The meetings will be held at the rooms of the Massachusetts Institute of Technology, and of the Boston Society of Natural History, occupying three closely adjoining buildings. The Association will be for one day a guest of Harvard University, and for another of the Essex Institute of Salem; the latter being the place of the museum of the Association, and its permanent office. A larger number than usual of the affiliated societies will meet in connection with the Association, including the American Forestry Association, the American Geological Society, the American Chemical Society, the Society of Economic Entomologists, the Society for the Promotion of Engineering Education, the Society for the Promotion of Agricultural Science, the American Mathematical Society, and several more. After the meeting excursions will be made to the White Mountains and to Cape Cod. The local committee has been fully organised under the honorary presidency of Governor Roger Wolcott. The honorary vice-presidents include the presidents of fourteen colleges and universities, besides many other prominent gentlemen. The local secretary is Prof. H. W. Tyler, of the Massachusetts Institute of Technology, 491 Boylston Street, Boston; and the general committee is a large and representative one, composed of the foremost citizens. The chairmen of the other committees are: Finance, the honorary treasurer, Colonel Henry L. Higginson; Reception, Dr. J. R. Chadwick; Rooms for meeting, Prof. Charles R. Cross; Invitations to foreign guests, Dr. Henry P. Bowditch; Excursions, General Francis H. Appleton; Cambridge committee, Prof. Charles W. Eliot, of Harvard University; Salem committee, Hon. Robert S. Rantoul, president of the Essex Institute; Executive committee, Prof. W. T. Sedgwick. An unusual feature is the committee for the reception of foreign guests. The circular explains that special efforts will be made to secure the presence of many eminent men of science from abroad.

A BUST of the late Prof. P. Schützenberger, the distinguished chemist, was unveiled at the Paris École de physique et de chimie industrielles on April 3. Prof. Schützenberger was the founder and first director of the school, and the bust is a testimony of the affection in which his memory is held by old students.

OLD students and admirers of Dr. W. K. Brooks, professor of zoology in the Johns Hopkins University, Baltimore, presented him with his portrait, painted by Mr. T. C. Corner, upon the occasion of the fiftieth anniversary of his birth on March 25. Many leading zoologists of the United States took part in this expression of esteem for Prof. Brooks.

THE autumn congress of the Sanitary Institute will be held this year in Birmingham, under the presidency of Sir Joseph Fayrer, Bart., K.C.S.I., F.R.S., commencing on September 27.

THE annual exposition organised by the Société Français de Physique will open to-day with a visit to the works of the Paris Compressed Air Company. On Friday and Saturday evening a large collection of apparatus used in recent physical investigations will be on view in the rooms of the Society; and on Saturday afternoon short addresses will be delivered by MM. Ducretet, Morin, and Hurmuzescu.

THE Liverpool Marine Biology Committee's Easter party, now at the Port Erin Biological Station, includes Mr. Isaac C. Thompson, Mr. Frank J. Cole, Mr. R. A. Dawson, Mr. H. C. Chadwick, Prof. Herdman, and several students from University College, Liverpool. Prof. Boyce and others are expected later in April. The Lancashire Sea Fisheries steamer is also at Port Erin, and several dredging and trawling expeditions are taking place. Spawn of several fishes has been obtained, and fertilised, and is now developing in the tanks. Under the care of Mr. Chadwick, Curator of the Station, the aquarium is in a flourishing condition, and contains a number of interesting animals, some of which are spawning. A recent addition to the laboratory accommodation at the Station has been completed, which gives five additional work windows for students, so that there is now plenty of room for other workers.

DR. H. M. FERNANDO will probably be the director of the Bacteriological Institute to be opened in Colombo shortly. The final plans for the building have been completed, and the work will be taken in hand at once. It is expected that the Institute will be opened by the beginning of next year.

WE learn from *Science* that the United States Senate has passed a Bill for the protection of song birds, providing that the importation into the United States of birds, feathers, or parts of birds for ornamental purposes be prohibited, and prohibiting the transportation or sale of such articles in any territory of the United States or in the District of Columbia.

THE vanguard of exploring expeditions for the season is that of Dr. Carl Lumholtz and Dr. Hrdlicka, who left the American Museum of Natural History a few days ago in search of anthropological specimens for the museum. This will be followed in a few weeks by an expedition to the North-west, undertaken also for anthropological research, by Dr. Laufer, Mr. Gerard Fowke, Mr. R. Dixon, and Mr. H. Smith.

THE most violent earthquake in California since 1872 was felt on Thursday night, March 31. The shock was felt only in Northern California. The direction of vibrations was from east to west; and they were very heavy in a small area. The seismograph showed the duration of the earthquake to have been between thirty and forty seconds at the University of California, Berkeley. Damage was done to buildings at San Francisco and Vallejo; but no loss of life has been reported.

THE death of Prof. Salomon Stricker, the distinguished professor of experimental and general pathology in the University of Vienna, at the age of sixty-five, is announced in the *British Medical Journal*. Only a week or two ago Prof. Stricker celebrated the twenty-fifth anniversary of his appointment as professor, and the occasion was celebrated by presenting him with a *Festschrift* entitled "Thirty Years of Experimental Pathology," the list of contributors including the names of E. Albert, A. Spina, G. Gaertner, Dr. E. Klein, and many other pathologists and histologists of note.

M. DE FONVIELLE writes:—The 1898 session of the international balloon scientific conference was held in Strasburg with great success. A large number of resolutions were adopted referring to the ascent of free balloons carrying registering apparatus, and balloons with meteorological and photographic instruments. The conference passed a vote in favour of the extension of kite experiments with recording apparatus or kite-balloons to the international meteorological stations, in order to procure better information on prevailing meteorological influences. It was resolved that an international experiment

should take place at the beginning of June. In addition to the Paris, Strasburg, Berlin, and Petersburg stations, two new stations will be established in Vienna at the expense of the Minister of War, and in Brussels. The expenses will be supported by the Belgian-Deutsch Society of Astronomy, which sent to Strasburg, as their representative, M. Fievre, one of their secretaries. The next meeting will take place in Paris in 1900, on the occasion of the forthcoming exposition. Among the members present at the recent meeting were the director of the Russian Meteorological Service; Commander Kovanko, director of the Russian Aeronautical Service; Herr Assmann and Dr. Berson, of the Berlin Meteorological Institute; M. Cailletet, member of the French Academy of Sciences; M. Teisserend de Bort; Mr. Rotch, director of the Blue Hill Observatory in Pennsylvania; M. Besançon; and Prof. Heim, the Swiss geologist, professor in the Zürich Polytechnicum.

WE regret to see that Mr. James I'Anson, an occasional contributor to our correspondence columns, died a few days ago. From the *Engineer* we learn that Mr. I'Anson was born at Gateshead in 1845, and came of an old North-country family. Soon after leaving school he commenced his apprenticeship as a mechanical engineer, and in 1866 he entered the engineering works of the late firm of Charles I'Anson and Co., becoming subsequently a partner. Some time after he became managing partner, a position which he held until his retirement in 1885. Mr. I'Anson was for many years a Fellow of the Geological Society, and he also sat upon the Council of the Mineralogical Society of Great Britain and Ireland. He was a member of the Iron and Steel Institute and of the North of England Institute of Mining and Mechanical Engineers, to whose proceedings he contributed papers, as also to those of the Cleveland Institute of Engineers, the Mineralogical Society, and the British Archæological Association.

AMONG the problems interesting to the physicist and mathematician which are discussed at the meetings of the Institution of Naval Architects, few open up such a wide field of inquiry as those which form the subject of Prof. H. S. Hele-Shaw's paper, entitled "Investigation of the nature of surface-resistance of water, and of stream-line motion under certain experimental conditions," read before the recent meeting of the Institution. In a previous paper, read last July, the author showed how the flow of water in two dimensions past obstacles of various cylindrical and prismatic forms could be investigated experimentally by the use of water containing a quantity of air flowing between two parallel plates of glass, the air rendering the water turbulent where the motion was most rapid. The photographs, which Prof. Hele-Shaw reproduces, show in every case a clear line round the boundary of the solid, indicating a thin film in which shearing motion takes place past the surface, while outside this comparatively calm region streaks of air are noticeable. The figures, moreover, show the presence of regions of dead water behind obstacles with blunt edges, fully confirming the view that to minimise resistance a solid must be made to taper at its stern end rather than at its bow end. In the present paper diagrams are given showing the variations in thickness of the entrained film according to the smoothness or roughness of the surface of the solid, the addition of soap to the water, and other circumstances. A second field of experiment has been developed by the use of thin films of water flowing between parallel plates, in which the stream-lines are shown by the introduction of coloured bands. Unless the film be very thin (about 0·5 mm.), the lines of colour become blurred, especially after flowing round an obstacle. The most remarkable result is the coincidence between the stream-lines in these experiments, where we are probably dealing with a case of laminated motion of a viscous liquid largely affected by the bounding plates of glass, and the corresponding stream-lines calculated mathematically for the irrotational motion of a perfect liquid in two dimensions. It has been one of the great objections to the mathematical theory of fluid motion that the conditions imposed by the mathematician differ considerably from those occurring in practice. Prof. Hele-Shaw's investigations, however, bid fair to bring hydrodynamics within the range of experimental sciences, besides fulfilling the object for which they were primarily undertaken—that of teaching naval architects how to minimise the surface-resistance on ships.

AT the meeting of the Institution of Civil Engineers on April 5, Mr. A. H. Preece gave an account of the present state of electricity supply in London. There are now in London eleven important companies and five vestries supplying electricity, and three other companies and three vestries are taking steps to start works. Five companies and three vestries supply the alternating current, and the remainder use direct-current systems. The direct-current systems are divisible into two classes—the high-pressure and the low-pressure. In the former, rotary transformers are used to reduce the high pressure to a low pressure, while the latter produces and distributes electricity at the same pressure at which it is supplied to consumers. The direct-current systems are applicable to compact areas, and, with the use of high pressure, to scattered or isolated compact areas. The chief advantages of the direct-current system are the possibility of using storage-batteries, which can not be employed with the alternating-current systems, greater efficiency in distribution, and greater adaptability to motive power. The favourite methods of distributing electricity are to transmit current at a high pressure in heavily-insulated cables in iron pipes, and current at a low pressure in insulated cable in stoneware conduits, or in cables heavily armoured and laid direct in the ground. Rubber is now little used, paper and jute, impregnated with insulating compounds, having been extensively adopted. The electric supply industry is rapidly growing, and no less than 40,000 h.p. is now being installed in London in order to meet the demand for electricity in the immediate future.

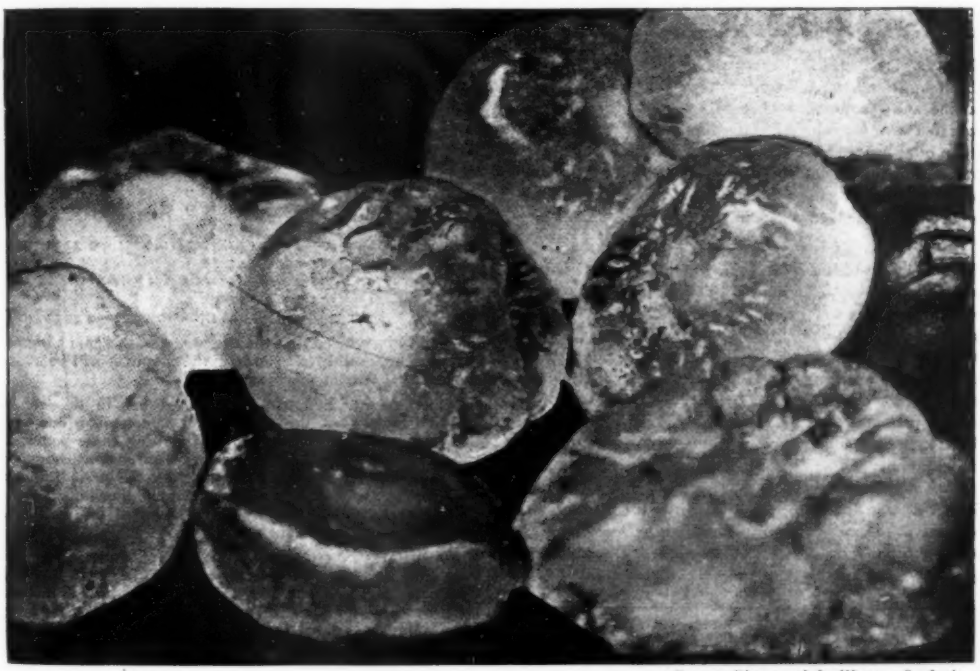
THE *Times* correspondent at Cairo makes the important announcement that M. Loret has discovered and opened at Thebes the tomb of Amenophis II, a king of the XVIII. dynasty, who reigned some 1500 years B.C. The tomb contains the mummies of Amenophis and of seven other kings, besides two mummies bearing no name, and four bodies which, though they have not been embalmed, are all in a complete state of preservation, with the features perfect. The hair upon each of these bodies is luxuriant, and the features are said to resemble to a marked degree those of the fellaheen of the present day. M. Loret's find is amongst the most interesting ever made in Egypt.

THE Central Physical Observatory of St. Petersburg has published an interesting pamphlet showing, for the whole of the Russian Empire, the absolute maximum and minimum temperatures at about 230 stations, accompanied by three maps, illustrating the above elements, and the ranges of temperature. The observations at some of the stations extend over a long series of years, *e.g.* St. Petersburg, 142 years; Moscow, 90 years; and Archangel, 80 years. The most remarkable temperatures and ranges are recorded in the Province of Yakutsk, in Siberia:—Verkoiansk, − 90° F. with a range of 182°·7; Markinskoe, − 85°·0, range 185°·2; Yakutsk, − 84°·1, range 185°·7. All these extreme minima occurred in the month of February, and the stations being a considerable distance apart, testify to their accuracy and to the great rigour of the winter of that locality. The work has been compiled by Mr. A. Varnek; but the text being in Russian only, detracts somewhat from its general usefulness.

THE sources of commercial india-rubber form the subject of two Cantor Lectures to be delivered at the Society of Arts on Monday, April 18 and 25, by Dr. D. Morris, C.M.G.

AN instructive article upon processes of alkali manufacture, with special reference to the works of Messrs. Brunner, Mond, and Co., appeared in yesterday's *Times*.

WE have received from Mr. C. Leeson Prince the summary for the year 1897 of meteorological records which he keeps at his observatory on Crowborough Hill, Sussex. Perhaps the most important event of the year occurred on May 30, when, as he says, "a more memorable thunderstorm passed over a portion of this country than has happened within living memory." This storm, from all accounts, did not actually occur at Crowborough Hill; but from its elevated position the progress of the storm, though twenty miles distant, could be watched for a considerable time. Mr. Prince gives a reproduction of some of the hailstones which had previously fallen at Seaford during the same storm. These were found to be still larger, as will be seen by the accompanying illustration showing the hailstones in their natural size.



[*From a Photograph by Wynter, Seaford.*

A reproduction (natural size) of some hailstones which fell at Seaford during the thunder-storm of May 30, 1897.

WE have received from Dr. T. Homén, of the University of Helsingfors, a laborious investigation, entitled "Der tägliche Wärmeumsatz im Boden und die Wärmestrahlung zwischen Himmel und Erde," being a continuation of a work published in 1894, in which the author dealt more particularly with earth temperature, evaporation and dew. In the present publication Dr. Homén attempts the determination of the amount of heat which enters various kinds of soil during the day, and the amount given up by radiation during the night. We are unable to give an adequate account here of the various interesting results contained in a quarto volume of about 150 pages, but we may mention that the experiments appear to have been carried out with great care. The thermometers were placed at various depths below and heights above the ground, and show clearly the effect of the soil upon the air temperature and humidity during the various hours of the day and night. The conditions of humidity were found to be very different between the level of the ground and the height of about 33 feet (at which the highest thermometers were placed), being less in the night and greater in the day in the lower than in the upper strata of air.

THE Rev. W. Sidgreaves, in his report of the Stonyhurst College Observatory for 1897, gives us the results of the meteorological and magnetical observations made during the past year, with notes and comments. In addition to these observations, which have been carried out with the utmost regularity, other branches of work have been followed. Thus preparation was made for photographing trails of the November meteors, five cameras having been mounted round the object-glass end of the equatorial, but the weather proved too unfavourable. Again, 174 drawings of solar spots and faculæ were made during the twelve months, and enlarged drawings of spots near the solar limb were undertaken to obtain evidence about the level of the umbra. As regards stellar spectroscopy 240 plates were exposed, the work in hand being directed to the sequence of spectrum differences of the yellow and red stars, from those of the solar type to the type of α Herculis. An appendix to this report contains the results of meteorological observations for 1897, made at St. Ignatius' College, Malta, by the Rev. J. F. Dobson.

Science states that in addition to the plans of the Geological Survey for explorations in Alaska, the Treasury Department are about starting five or six expeditions to explore the Yukon river,

Copper river, and other water routes of the Territory, the United States Congress having granted 100,000 dollars for the purpose.

SCIENTIFIC facts are presented to the public freely and attractively in three lectures which have been arranged at the Whitechapel Free Public Library and Museum. On Tuesday Prof. Hobday lectured on "The Horse and Dog and their relations and friends." On Tuesday, May 10, Prof. W. F. R. Weldon, F.R.S., will discourse upon "Butterflies"; and on June 7, Prof. Marshall Ward, F.R.S., will give an address upon "A Piece of Wood." Admission to the lectures is free by ticket, which can be obtained in the Museum and Library.

APPENDIX II. for 1898 of the *Kew Bulletin* is entirely occupied with a list of New Garden Plants of the year 1897, including also the most noteworthy of those which have been re-introduced after having been lost from cultivation. In addition to species and botanical varieties, all hybrids, whether introduced or of garden origin, with botanical names, and described for the first time in 1897, are included.

MESSRS. J. AND A. CHURCHILL announce that they will publish in a few days a new work on "The Blood: how to examine and diagnose its diseases," by Dr. Alfred C. Coles, illustrated with six coloured plates. They will also issue a fifth edition of "A Manual of Dental Anatomy, Human and Comparative," by Mr. Charles S. Tomes, F.R.S., with many new illustrations. The part dealing with comparative odontology has been expanded to meet the requirements of students of biology.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Grace Currie; a White-tailed Sea Eagle (*Haliætus albicilla*) from the Liautung Peninsula, China, presented by Mr. J. W. Carrell; ten Californian Quails (*Callipepla californica*) from California, presented by Captain Thos. Yardley Powles; a Common Viper (*Vipera berus*). British, presented by Mr. R. Tucker; an Egyptian Jerboa (*Dipus ægyptius*), four Egyptian Ichneumons (*Herpestes ichneumon*), six Gulls (*Larus*, sp. inc.), a Common Kestrel (*Tinnunculus alaudarius*) from Egypt, a Leopard (*Felis pardus*) from West Africa, a Reticulated Python (*Python reticulatus*) from Malacca, deposited; a Chimpanzee (*Anthropopithecus troglodytes*, ♂) from West Africa, a Rosy-billed Duck (*Metopiana peposaca*, ♀) from South America, purchased.

OUR ASTRONOMICAL COLUMN.

THE DOUBLING OF THE CANALS ON MARS.—The origin of the doubling of the canals visible on the surface of the planet Mars has again come to the front, and this time M. Antoniadi has put forward an explanation. His suggestion is that the doubling is only a phenomenon caused probably by the eye of the observer; in fact, it is the result of slight focussing errors when observing these markings. A full account of this curious cause of error is contributed to *Cosmos* (No. 687) by M. Th. Moreux, and M. Antoniadi himself gives a complete summary of his suggestion in the *Bulletin de la Société Astronomique de France* for April. According to the latter, a thin line, when gradually put slightly out of focus, becomes slowly double, the inner parts of which are blurred; in fact, a regular germination is observed. In addition to this, he finds that if several lines be made to cross at a point, all of these do not become double, but only certain of them. Not only do straight markings, but round and elongated spots become alike doubled. At the end of his paper, after remarking on the curious phenomenon of canals, as actually observed, becoming double in the course of a few hours, he says:—

"Ainsi, si Mars est couvert de 'canaux,' la vision imparfaite devra dédoubler ces lignes. Pareille vision indistincte peut provenir, ainsi que nous venons de le voir: 1° d'une minime erreur de mise au point; 2° d'oscillations diplopiques (fatigue) de l'œil. Voila ce qui doit fatalement arriver, el ce qui arrive en réalité."

M. Camille Flammarion tells us in the same journal that M. Adolphe de Bœ, of Anvers, in the year 1891 suggested, in a letter to him, that this doubling might be the result of secondary images which, under certain conditions, might be formed in the eye. M. Flammarion is, however, no great believer in this idea, as it does not seem to sufficiently explain all the phenomena of doubling, germination, &c., which have been observed on the surface of this interesting planet, although the arguments brought forward reproduce very ingeniously the greater part of the observations. With him we echo the sentiment of wishing to know what M. Schiaparelli has to say on the subject.

COMET PERRINE.—The latest elements and ephemeris of this comet have been calculated by Prof. H. Kreutz, who gives the results in No. 4 *Circular* recently distributed.

The elements computed from the observations of March 19, 23, 27 and 31, differ slightly from those we have previously given, being:—

T = 1898 March 17·37558 Berlin M.T.

$$\left.\begin{aligned} \omega &= 47^\circ\ 34'\ 12''\cdot1 \\ \Omega &= 262\ 33\ 59\cdot6 \\ i &= 72\ 27\ 48\cdot1 \end{aligned}\right\} 1898\cdot0$$

$$\log q = 0\cdot040842$$

The ephemeris for the ensuing week is as follows:—

1898.	R.A. h. m. s.	Dec.	log r	log Δ	Br.
April 14	23 7 15	+40 47·7	0·0757	0·2233	0·77
15	12 13	41 32·9			
16	17 15	42 16·9			
17	22 20	42 59·7			
18	27 27	43 41·3	0·0851	0·2330	0·71
19	32 37	44 21·6			
20	37 49	45 0·6			
21	43 3	45 38·4			
22	23 48 19	+46 15·0	0·0953	0·2438	0·64

It will be noticed that the brightness of this comet is gradually decreasing, and by the end of the month it will be about half that at the time of discovery.

THE APRIL LYRIDS.—As pointed out in this column on March 31 (p. 519), the April shower of meteors is due on 19-20 of this month. The conditions for viewing these bodies if they should be numerous will be very favourable, as the moon will be absent. As Mr. Denning tells us, the periodical maxima of this stream of Lyrids has a computed time of revolution of 415 years, a brilliant display having occurred on April 20 in the year 1803. The radiant point is 270°+32°.

THE MEUDON OBSERVATORY.—Prof. Janssen is evidently bringing together a very strong force at the Astro-Physical Observatory at Meudon. We hear now that, in addition to the other experienced astronomers who are working there, M. Deslandres has been transferred from Paris, and will in future continue his valuable spectroscopic researches at Meudon.

PREHISTORIC RUINS OF HONDURAS AND YUCATAN.

IN 1891 the Directors of the Peabody Museum secured from the Government of Honduras (through the liberality of Mr. C. Bowditch, of Boston) the right to explore the ruins of Copan, and to take away half of the objects found in the excavations, during a period of ten years. The preliminary report of the exploration,[1] now published by the Directors of the Museum, gives the result of the first two years' work, and is accompanied by a plan and many excellent photographic plates.

All those interested in American archæology must be for ever grateful to the Committee directing the expedition for one instruction given to the explorers; it was to the effect that a wall should be built round the principal group of ruined structures and carved monoliths, so as to save them, if possible, from further destruction. This work has now been most satisfactorily carried out, and the ruins, which were always safe from approach on the river face, are now enclosed on the land side by a substantial stone wall nearly one mile in length.

[1] *Memoirs of the Peabody Museum, &c.* Vol. i. No. 1: "Prehistoric Ruins of Copan, Honduras." "A Preliminary Report of the Explorations by the Museum, 1891–95."

Examination and excavation have thrown no light on the age of the buildings; in fact, the further examination has only complicated the problem, as clearer proofs are forthcoming that the mass of masonry has grown up in the course of ages, old foundations being enlarged and covered in turn by new build-

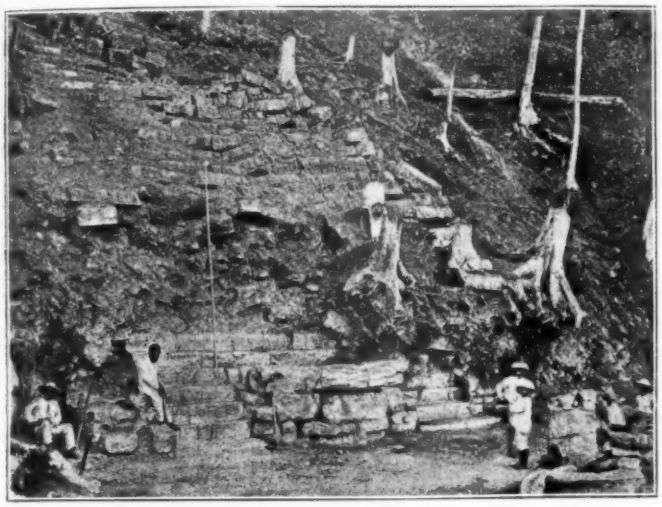


FIG. 1.—Foot of the hieroglyphic stairway.

ings. One of the most interesting discoveries made during the explorations is connected with the great hieroglyphic stairway which leads to the summit of one of the largest foundation mounds. The steps of this stairway had become disjointed and displaced, so that it is not easy to determine the exact plan of its construction; and it was probably in order to gain further information on this point that an excavation was commenced near the foot of the steps, which revealed the fact that the hieroglyphic stairway had been superimposed on an earlier stairway, which also had a clear cut inscription on the face of each step. A description of these stairways has been deferred until further exploration leads to a better understanding of their structure; and it is to be hoped that the greatest care has been taken in numbering and recording the position of the stones, so that the continuity of the glyphs in the inscriptions may be retained, as the result of a comparison of the initial dates of the two inscriptions (one of which is in the rarer form of picture writing) will probably prove to be of the greatest value.

No regular burying-place has been found at Copan, but a number of isolated tombs have been explored, in which human bones were discovered in more or less disintegrated condition. The human incisor teeth were found, in many instances, to be ornamented by the inlaying of a little circular bit of jadeite, fitted into a hole drilled into the front of the tooth. These jadeite ornaments are slightly rounded outward, and highly polished. Many interesting pieces of pottery were secured during the excavations, some decorated with painted designs, others (such as the terra-cotta vase in the form of the head of a carnivorous animal, figured on p. 48 of the Report) remarkable for the artistic skill shown in the modelling. The most interesting object of all, however, was not a piece of pottery, but the actual skull of a peccary covered with beautifully incised figures and hieroglyphs. I have had the good fortune to be able to examine this skull in the Peabody Museum, and can only express an earnest hope that photographs of it, and drawings of the incised ornament, may be included in the further publications which are promised us.

During the second year's work a sad event occurred in the death of Mr. J. G. Owens, the leader of the expedition, who contracted a malignant fever during a journey to the coast, and died soon after his return to the ruins, where he lies buried in the great Plaza surrounded by those strangely carved monoliths in which he had learned to take so keen an interest.

The Exploration Committee of the Peabody Institute has not confined itself to organising expeditions in Honduras only; it has for some years worked with equal success in furthering the examination of ancient ruins in the peninsula of Yucatan. There, under the direction of Mr. Edward H. Thompson, for some time the United States Consul in Merida, a thorough examination has been made of the ruins of Labná; but, unfortunately, the report on that portion of the work has not yet been made public, and the second article in the *Memoirs* of the Museum deals only with the exploration of the Cave of Loltun,[1] which Mr. Thompson undertook in 1888 before setting to work at Labná—from which it is twelve miles distant—and continued in 1890–91.

One peculiarity of Yucatan is that it is a country without any rivers. The copious rainfall soaks through the porous limestone rock, and it is to the pools in the deep caves or "cenotes" that the Indian of to-day looks for his supply of water, as his forefathers did before him. Under such conditions the caves were sure to yield to the explorer many signs of human visitation, but it was of the greatest importance to ascertain whether the

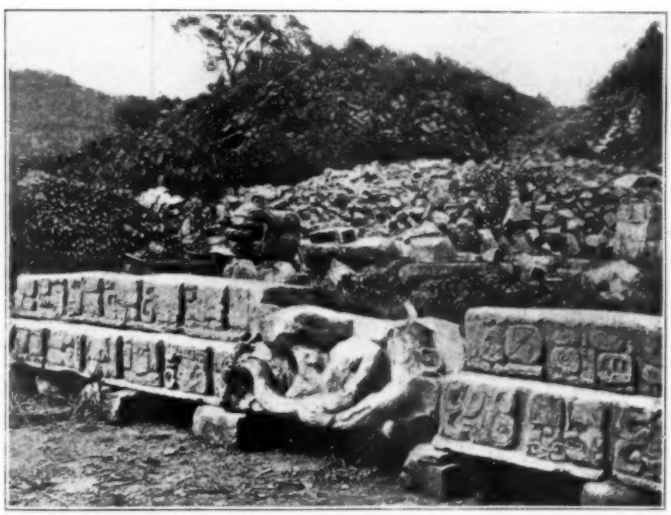


FIG. 2.—Two steps from the hieroglyphic stairway.

evidences of human handiwork should be attributed only to the race inhabiting the land at the time of the Spanish conquest, or

[1] *Memoirs of the Peabody Museum*, &c., vol. i. No. 2: "Cave of Loltun, Yucatan." "Report of Explorations by the Museum, 1888–89 and 1890–91," by Edward H. Thompson.

whether they could be ascribed to some earlier and more primitive race.

The interest attaching to the result of Mr. Thompson's labours has been somewhat discounted by the publication in 1896 of the admirable treatise on the caves of Yucatan by Mr. Henry Mercer, but to Mr. Thompson must remain the credit of having been first in the field.

Mr. Thompson's report is accompanied by some capital photographs of the rock carvings, taken by Mr. H. N. Sweet and

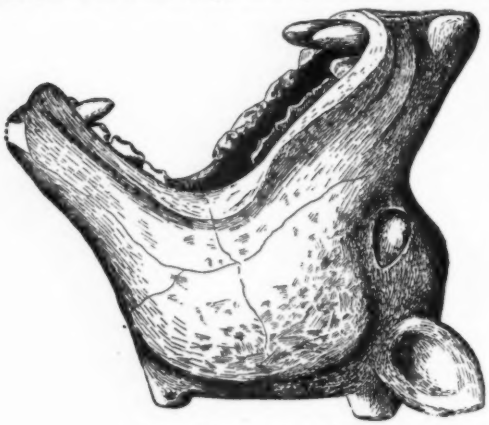


FIG. 3.—Terra-cotta vase (⅓ size

Mr. M. H. Saville, showing them all to be rude and primitive in character, with the single exception of a life-sized human figure with the mutilated remains of a date expressed in the Maya notation above its head, which is just such a figure as one might find on the walls of the ruined temples above ground.

Mr. Thompson's main conclusion is that from the earliest period of the cave's use as a human habitation the people seem to

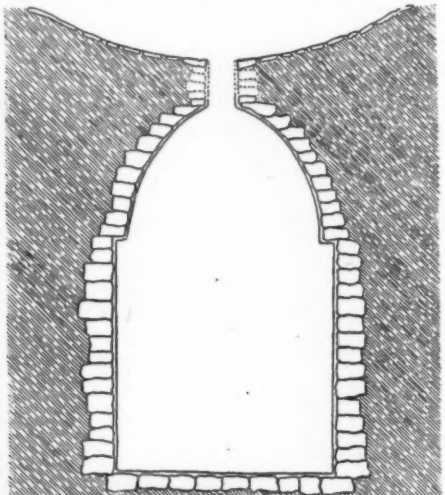


FIG. 4.—Section of a chaltune.

have been of the same manners, religious customs, and household habits as those who built the great structures above ground now in ruins. Mr. Mercer, after pointing out that the caves were not properly dwellings but rather temporary halting-places, has given it as his opinion, (1) that no earlier inhabitant preceded the builders of the ruined cities of Yucatan; (2) that the people revealed in the caves had reached the country in geologically recent times; (3) that these people, substantially the ancestors of the present Maya Indians, had not developed their culture in Yucatan, but had brought it with them from somewhere else.

In a country where water is so scarce, it is only reasonable to suppose that the inhabitants would have devised some means of storing the precious fluid; and in the existence of numerous "chaltunes" we have almost certain evidence of the means of storage most commonly employed. These chaltunes are "single chambers of a vault-like appearance, built from ten to fifteen feet beneath the surface of the ground, and communicating with the outer world by means of a narrow well-like opening placed near the apex of the vaulted roof." They are somewhat irregular in shape, but the prevailing form is shown in the following section.

Mr. Thompson paid particular attention to the chaltunes amongst the ruins of Labná,[1] a neighbourhood where—if the opinion that they were used for the storage of water be correct—it is likely that they would be found in considerable numbers, as the nearest permanent water supply is found at the Cave of Loltun, twelve miles distant. Mr. Thompson is of opinion that many of the rougher class of chaltunes were formed in the cavities or pockets from which the white earth, called by the natives "zahcab," had been taken. "This earth is of a

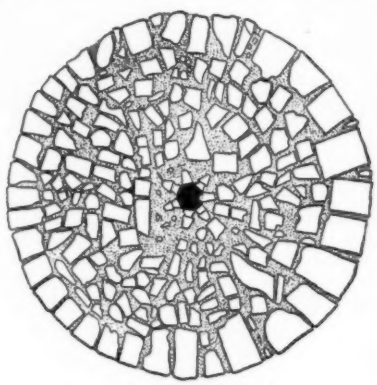


FIG. 5.—The mouth of a chaltune.

peculiar character, and served the ancient builders, as it does those of the present day, as a building material to mix with lime in place of siliceous sand, which is practically unknown in Yucatan." The other chaltunes are well-built chambers, having their walls, roof, and floor of dressed stones, and finished with a coating of fine, hard stucco. In the ruins of Labná, each edifice and each terrace was found to be provided with one or more of these subterranean chambers, the largest of which, however, would not hold more than 10,000 gallons.

Many of the chaltunes had become hopelessly ruined, and many were filled up with earth and rubbish; but some of them had been purposely sealed up by the ancient inhabitants, and these presented a new and interesting field for investigation. Human bones and various objects of human workmanship were found among the deposits at the bottom of the chambers; and Mr. Thompson is led to the conclusion that many of these singular structures, after having been first used as reservoirs, were finally used as depositories for human remains, probably secondary burials, in connection with some special rite, after which the entrance of the chaltune was closed and cemented.

ALFRED P. MAUDSLAY.

P.S.—While the foregoing was in the printer's hands, an article on Copan has been brought to my notice, published in the *Century Magazine* for January, in which Mr. Gordon states that he has finished his work on the hieroglyphic stairway. It proves to have been a single flight of steps, and not one stairway built over another. The illustration given on p. 569 shows the foot of the stairway as it was at first disclosed

[1] *Memoirs of the Peabody Museum*, vol. 1. No. 3: "The Chaltunes of Labná, Yucatan." "Report of Explorations by the Museum 1888–89 and 1890–91," by Edward H. Thompson.

by Mr. Owens's excavation. The disjointed stones of the upper part of the stairway (some of which have already been cleared away) had slid down bodily from above and, until the excavation was made, had completely hidden the lower part of the stairway.

It is to be hoped that the next part of the *Memoirs of the Peabody Institute* will give the details of this interesting work, and a more accurate (if less ambitious) drawing than that of the "restored" stairway published in the *Century Magazine*. If it has been possible to preserve the continuity of the inscription on the steps, Mr. Gordon's labours will have added to our store one of the longest and most valuable inscriptions yet found in Central America.

Surely it is through an unintentional error that the drawing of the Jaguar stairway, on page 409 of the *Century*, is ascribed to Henry Sandham. A. P. M.

RECENT PAPERS ON GLACIATION.

AT the Toronto meeting of the British Association the numerous papers bearing on the glaciation of the North American continent were of exceptional interest to the British student of glacial geology, inasmuch as they brought prominently to mind the methods adopted by the Canadian and American glacialists, which differ in many respects from those to which we have become accustomed on this side of the Atlantic.

In no branch of earth-lore is the influence of his environment more strongly impressed upon the worker than in stratigraphical geology, and the effect of the simple topographical forms and of the enormous extent over which the glacial deposits are distributed in North America, has been to give a broader grasp and bolder tone to the general run of its glacial literature. This was admirably illustrated by the work brought forward at the meeting. In the British Islands, from the abundance of natural and artificial sections as well as from the complexity and narrow limits of the topography, the lithological composition of the drift deposits is usually made the pivot of the studies, while in America it is rather the arrangement of the drift in regard to the general physical features which is held to be of paramount import.

The following comments on the papers read at Toronto have been written from the standpoint of a British glacialist anxious to find wherein he might profit by the adoption at home of the Transatlantic methods.

To realise the extent of the field in North America it must be remembered that the total area of the Dominion of Canada, about 3,616,000 square miles or not much less than the whole of Europe, can show, in one form or another, traces of the Great Ice Age in every part, and that the same glaciated area further extends over a region about one-fifth as large to the southward of the Canadian border. It is not surprising, then, that the study of glacial phenomena should have attracted so many able workers in Canada and the United States.

The exploratory work of Russell, Wright and others upon the existing glaciers of Alaska, and of Chamberlin, Peary, Barton and others upon the edge of the ice-sheet in Greenland has been more readily assimilated by American than by British glacialists, and its influence is perceptible throughout their researches. It is true that the Danish explorers had already made known to us the leading facts relating to the latter region, but their studies were not perhaps made so directly from the standpoint of the glacial geologist as those of the above-mentioned observers, nor were their results so accessible to the English-speaking geologists. But since Russell, by his investigation of the Malaspina Glacier, with its forested moraine-covered margin sheltering a varied fauna and flora, has shown how widely different are the conditions of Piedmont ice and Alpine glaciers, and since Chamberlin, in describing the mode of occurrence of the detrital matter in the basal layers of Greenland ice-tongues, has thrown so much new light on the whole question of drift-deposition, the British glacialist would do well to recognise, with his colleagues across the Atlantic, that the glaciers of the Alps do not afford the best introduction to the study of glacial geology. It is clear that the Alpine conditions are, in many respects, very different from those under which the ice-sheets of the Glacial period did their work.

As regards the cause of the Great Ice Age, we heard at the Toronto meeting two interesting communications. That of Prof. T. C. Chamberlin, outlined in a former number of NATURE (September 16), was avowedly altogether speculative, and belonged to the domain of earth-physics rather than to geology in the ordinary sense. The other was that in which Dr. J. W. Spencer ably advocated his well-known views on the continental elevation of the Glacial epoch.

Dr. Spencer described a large number of drowned valleys, often extending from the mouths of the great modern rivers across the submarine plateaus at various depths, reaching to even 12,000 feet or more, and recognisable as far northward as Labrador. He stated that upon tracing northward the deposits occupying the great valleys, he found that glacial accumulations occur in New Jersey between the Lafayette formation, which is the latest horizon dissected by the great valleys, provisionally regarded as of late Pliocene age, and the Columbia formation, which is mid-Pleistocene. From all these considerations he concluded that the eastern portion of North America stood more than two miles above the sea during the earlier Pleistocene epoch.

On other evidence he judged that the Mexican plateau was mostly depressed to near sea level during the times of the high elevation of the eastern portion of the continent; and that, with the subsidence of the eastern region, the western side of the continent was elevated from 6000 to 10,000 feet or more. The separation of the Atlantic and Pacific Oceans he regards as only of recent date. These changes of levels and the dependent variations of currents, &c., seem, in his opinion, to be sufficient cause for the Glacial period.

As Dr. Spencer pointed out, his views are practically those which have been advocated by Lyell and many others. But while a pre-glacial elevation of the North American continent is generally acknowledged by geologists, the extent of this elevation is not usually admitted to have been even approximately as large as Dr. Spencer would claim, and the difficulties in accounting for the widespread glaciation of the Northern Hemisphere by the effects of elevation alone are so great that the defenders of this hypothesis are at present few.

There is a somewhat remarkable blank in the evidence to hand in North America as to the conditions immediately antecedent to the Glacial Period, nothing equivalent to the Forest Bed Series and associated pre-glacial deposits, of which we possess such excellent sections on our Norfolk coast, having yet been discovered. For this reason the paper of Mr. R. Chalmers, of the Geological Survey of Canada, on the pre-glacial decay of rocks in Eastern Canada, was of especial interest. Mr. Chalmers showed that in the region he described, beds of decomposed rock, of variable thickness and more or less modified, occur wherever the surface of the rocks has not been abraded by Pleistocene ice, though boulder clay may often be found overlying them.

He gave the following general section of these beds in descending order:—(1) Transported and stratified water-worn gravel with beds of fine sand and clay. (2) Coarse stratified gravels, usually yellow and oxidised, the materials wholly local. (3) Sedentary rotted rock, passing into solid rock beneath.

There seems at present to be no evidence as to the precise age of these beds in Eastern Canada; but Mr. Chalmers pointed out that somewhat similar deposits occurring at the western base of the Green Mountains in Vermont, have yielded vegetable remains by which Lequereux, many years ago, referred them to the Miocene. He concludes that the general aspect of the dry land in Eastern Canada previous to the Glacial period must have been nearly similar to that of the region south of the glaciated zone in North America.

The occurrence of similar local rubble in sheltered situations beneath the drift has often been noted in the British Islands, and the ease with which such loose-lying material would become incorporated into the basal layers of an advancing ice-sheet has been frequently discussed. On both sides of the Atlantic it seems more probable that the greater bulk of the glacial deposits was derived from this source, rather than from the direct erosive action of the ice upon the solid rocks.

With regard to the initial stages of the glaciation, while the European glacialist looks to the highest ground in the northern part of his continent and its islands—to the mountains of Scandinavia, of Scotland, England, Wales and Ireland, and of Switzerland—as the great gathering grounds, it is generally recognised that in North America, with the exception of the Cordilleran mass in the extreme west, the glaciation commenced and spread from the comparatively low ground in the north of the continent and moved southward against the slope of the land, the mountains near its south-eastern margin being

whether they could be ascribed to some earlier and more primitive race.

The interest attaching to the result of Mr. Thompson's labours has been somewhat discounted by the publication in 1896 of the admirable treatise on the caves of Yucatan by Mr. Henry Mercer, but to Mr. Thompson must remain the credit of having been first in the field.

Mr. Thompson's report is accompanied by some capital photographs of the rock carvings, taken by Mr. H. N. Sweet and

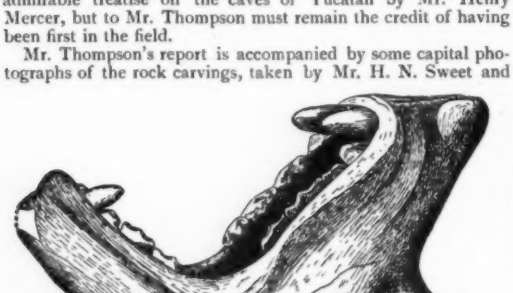


FIG. 3.—Terra-cotta vase (¼ size

Mr. M. H. Saville, showing them all to be rude and primitive in character, with the single exception of a life-sized human figure with the mutilated remains of a date expressed in the Maya notation above its head, which is just such a figure as one might find on the walls of the ruined temples above ground.

Mr. Thompson's main conclusion is that from the earliest period of the cave's use as a human habitation the people seem to

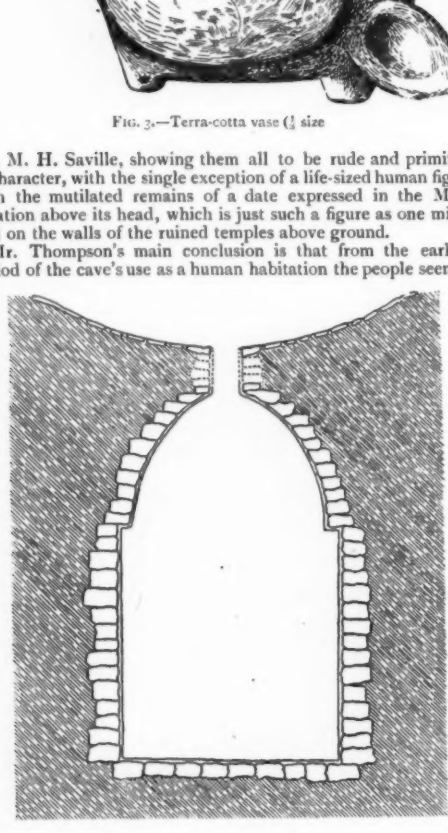


FIG. 4.—Section of a chaltune.

have been of the same manners, religious customs, and household habits as those who built the great structures above ground now in ruins. Mr. Mercer, after pointing out that the caves were not properly dwellings but rather temporary halting-places, has given it as his opinion, (1) that no earlier inhabitant preceded the builders of the ruined cities of Yucatan; (2) that the people revealed in the caves had reached the country in geologically recent times; (3) that these people, substantially the ancestors of the present Maya Indians, had not developed their culture in Yucatan, but had brought it with them from somewhere else.

In a country where water is so scarce, it is only reasonable to suppose that the inhabitants would have devised some means of storing the precious fluid; and in the existence of numerous "chaltunes" we have almost certain evidence of the means of storage most commonly employed. These chaltunes are "single chambers of a vault-like appearance, built from ten to fifteen feet beneath the surface of the ground, and communicating with the outer world by means of a narrow well-like opening placed near the apex of the vaulted roof." They are somewhat irregular in shape, but the prevailing form is shown in the following section.

Mr. Thompson paid particular attention to the chaltunes amongst the ruins of Labná,[1] a neighbourhood where—if the opinion that they were used for the storage of water be correct—it is likely that they would be found in considerable numbers, as the nearest permanent water supply is found at the Cave of Loltun, twelve miles distant. Mr. Thompson is of opinion that many of the rougher class of chaltunes were formed in the cavities or pockets from which the white earth, called by the natives "zahcab," had been taken. "This earth is of a

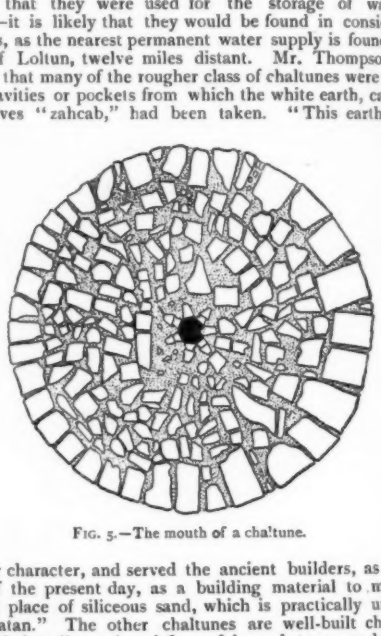


FIG. 5.—The mouth of a chaltune.

peculiar character, and served the ancient builders, as it does those of the present day, as a building material to mix with lime in place of siliceous sand, which is practically unknown in Yucatan." The other chaltunes are well-built chambers, having their walls, roof, and floor of dressed stones, and finished with a coating of fine, hard stucco. In the ruins of Labná, each edifice and each terrace was found to be provided with one or more of these subterranean chambers, the largest of which, however, would not hold more than 10,000 gallons.

Many of the chaltunes had become hopelessly ruined, and many were filled up with earth and rubbish; but some of them had been purposely sealed up by the ancient inhabitants, and these presented a new and interesting field for investigation. Human bones and various objects of human workmanship were found among the deposits at the bottom of the chambers; and Mr. Thompson is led to the conclusion that many of these singular structures, after having been first used as reservoirs, were finally used as depositories for human remains, probably secondary burials, in connection with some special rite, after which the entrance of the chaltune was closed and cemented.

ALFRED P. MAUDSLAY.

P.S.—While the foregoing was in the printer's hands, an article on Copan has been brought to my notice, published in the *Century Magazine* for January, in which Mr. Gordon states that he has finished his work on the hieroglyphic stairway. It proves to have been a single flight of steps, and not one stairway built over another. The illustration given on p. 569 shows the foot of the stairway as it was at first disclosed

[1] *Memoirs of the Peabody Museum*, vol. 1. No. 3: "The Chaltunes of Labná, Yucatan." "Report of Explorations by the Museum 1888-89 and 1890-91," by Edward H. Thompson.

by Mr. Owens's excavation. The disjointed stones of the upper part of the stairway (some of which have already been cleared away) had slid down bodily from above and, until the excavation was made, had completely hidden the lower part of the stairway.

It is to be hoped that the next part of the *Memoirs of the Peabody Institute* will give the details of this interesting work, and a more accurate (if less ambitious) drawing than that of the "restored" stairway published in the *Century Magazine*. If it has been possible to preserve the continuity of the inscription on the steps, Mr. Gordon's labours will have added to our store one of the longest and most valuable inscriptions yet found in Central America.

Surely it is through an unintentional error that the drawing of the Jaguar stairway, on page 409 of the *Century*, is ascribed to Henry Sandham. A. P. M.

RECENT PAPERS ON GLACIATION.

AT the Toronto meeting of the British Association the numerous papers bearing on the glaciation of the North American continent were of exceptional interest to the British student of glacial geology, inasmuch as they brought prominently to mind the methods adopted by the Canadian and American glacialists, which differ in many respects from those to which we have become accustomed on this side of the Atlantic.

In no branch of earth-lore is the influence of his environment more strongly impressed upon the worker than in stratigraphical geology, and the effect of the simple topographical forms and of the enormous extent over which the glacial deposits are distributed in North America, has been to give a broader grasp and bolder tone to the general run of its glacial literature. This was admirably illustrated by the work brought forward at the meeting. In the British Islands, from the abundance of natural and artificial sections as well as from the complexity and narrow limits of the topography, the lithological composition of the drift deposits is usually made the pivot of the studies, while in America it is rather the arrangement of the drift in regard to the general physical features which is held to be of paramount import.

The following comments on the papers read at Toronto have been written from the standpoint of a British glacialist anxious to find wherein he might profit by the adoption at home of the Transatlantic methods.

To realise the extent of the field in North America it must be remembered that the total area of the Dominion of Canada, about 3,616,000 square miles or not much less than the whole of Europe, can show, in one form or another, traces of the Great Ice Age in every part, and that the same glaciated area further extends over a region about one-fifth as large to the southward of the Canadian border. It is not surprising, then, that the study of glacial phenomena should have attracted so many able workers in Canada and the United States.

The exploratory work of Russell, Wright and others upon the existing glaciers of Alaska, and of Chamberlin, Peary, Barton and others upon the edge of the ice-sheet in Greenland has been more readily assimilated by American than by British glacialists, and its influence is perceptible throughout their researches. It is true that the Danish explorers had already made known to us the leading facts relating to the latter region, but their studies were not perhaps made so directly from the standpoint of the glacial geologist as those of the above-mentioned observers, nor were their results so accessible to the English-speaking geologists. But since Russell, by his investigation of the Malaspina Glacier, with its forested moraine-covered margin sheltering a varied fauna and flora, has shown how widely different are the conditions of Piedmont ice and Alpine glaciers, and since Chamberlin, in describing the mode of occurrence of the detrital matter in the basal layers of Greenland ice-tongues, has thrown so much new light on the whole question of drift-deposition, the British glacialist would do well to recognise, with his colleagues across the Atlantic, that the glaciers of the Alps do not afford the best introduction to the study of glacial geology. It is clear that the Alpine conditions are, in many respects, very different from those under which the ice-sheets of the Glacial period did their work.

As regards the cause of the Great Ice Age, we heard at the Toronto meeting two interesting communications. That of Prof. T. C. Chamberlin, outlined in a former number of NATURE (September 16), was avowedly altogether speculative, and belonged to the domain of earth-physics rather than to geology in the ordinary sense. The other was that in which Dr. J. W. Spencer ably advocated his well-known views on the continental elevation of the Glacial epoch.

Dr. Spencer described a large number of drowned valleys, often extending from the mouths of the great modern rivers across the submarine plateaus at various depths, reaching to even 12,000 feet or more, and recognisable as far northward as Labrador. He stated that upon tracing northward the deposits occupying the great valleys, he found that glacial accumulations occur in New Jersey between the Lafayette formation, which is the latest horizon dissected by the great valleys, provisionally regarded as of late Pliocene age, and the Columbia formation, which is mid-Pleistocene. From all these considerations he concluded that the eastern portion of North America stood more than two miles above the sea during the earlier Pleistocene epoch.

On other evidence he judged that the Mexican plateau was mostly depressed to near sea level during the times of the high elevation of the eastern portion of the continent; and that, with the subsidence of the eastern region, the western side of the continent was elevated from 6000 to 10,000 feet or more. The separation of the Atlantic and Pacific Oceans he regards as only of recent date. These changes of levels and the dependent variations of currents, &c., seem, in his opinion, to be sufficient cause for the Glacial period.

As Dr. Spencer pointed out, his views are practically those which have been advocated by Lyell and many others. But while a pre-glacial elevation of the North American continent is generally acknowledged by geologists, the extent of this elevation is not usually admitted to have been even approximately as large as Dr. Spencer would claim, and the difficulties in accounting for the widespread glaciation of the Northern Hemisphere by the effects of elevation alone are so great that the defenders of this hypothesis are at present few.

There is a somewhat remarkable blank in the evidence to hand in North America as to the conditions immediately antecedent to the Glacial Period, nothing equivalent to the Forest Bed Series and associated pre-glacial deposits, of which we possess such excellent sections on our Norfolk coast, having yet been discovered. For this reason the paper of Mr. R. Chalmers, of the Geological Survey of Canada, on the pre-glacial decay of rocks in Eastern Canada, was of especial interest. Mr. Chalmers showed that in the region he described, beds of decomposed rock, of variable thickness and more or less modified, occur wherever the surface of the rocks has not been abraded by Pleistocene ice, though boulder clay may often be found overlying them.

He gave the following general section of these beds in descending order:—(1) Transported and stratified water-worn gravel with beds of fine sand and clay. (2) Coarse stratified gravels, usually yellow and oxidised, the materials wholly local. (3) Sedentary rotted rock, passing into solid rock beneath.

There seems at present to be no evidence as to the precise age of these beds in Eastern Canada; but Mr. Chalmers pointed out that somewhat similar deposits occurring at the western base of the Green Mountains in Vermont, have yielded vegetable remains by which Lequereux, many years ago, referred them to the Miocene. He concludes that the general aspect of the dry land in Eastern Canada previous to the Glacial period must have been nearly similar to that of the region south of the glaciated zone in North America.

The occurrence of similar local rubble in sheltered situations beneath the drift has often been noted in the British Islands, and the ease with which such loose-lying material would become incorporated into the basal layers of an advancing ice-sheet has been frequently discussed. On both sides of the Atlantic it seems more probable that the greater bulk of the glacial deposits was derived from this source, rather than from the direct erosive action of the ice upon the solid rocks.

With regard to the initial stages of the glaciation, while the European glacialist looks to the highest ground in the northern part of his continent and its islands—to the mountains of Scandinavia, of Scotland, England, Wales and Ireland, and of Switzerland—as the great gathering grounds, it is generally recognised that in North America, with the exception of the Cordilleran mass in the extreme west, the glaciation commenced and spread from the comparatively low ground in the north of the continent and moved southward against the slope of the land, the mountains near its south-eastern margin being

obstacles in its course rather than aids to its accumulation. It is, indeed, probable that in Eastern Europe too much stress has been laid on the importance of the hill-ranges as glacial centres, since there is much evidence to indicate that, at any rate during the maximum glaciation, the movement, and probably therefore the growth, of the great sheets was more or less independent of the orographic features. In this connection the explorations of Mr. J. B. Tyrrell, of the Canadian Survey, in that birthplace of ice-sheets the desolate region to the westward of Hudson Bay, are of the highest importance. In his paper on the glaciation of North-western Canada, Mr. Tyrrell stated that no evidence was discovered of any great elevation of this central area in Glacial, or immediately Pre-glacial times, and it would seem not improbable that the land then stood at about the same height above the sea as at present; and that the moisture giving rise to the immense precipitation of snow would probably be derived from the adjacent waters of Hudson Bay and the Arctic Ocean.

In the region immediately west of Hudson Bay, the earliest glaciation of which he could recognise any traces flowed outwards from a gathering-ground which lay north or north-west of Doobaunt Lake. Subsequently this gathering-ground moved south-eastward, until it centred over the country between Doobaunt and Yath-kyed Lakes. From one or other of these centres the ice seems to him to have flowed westward and south-westward to within a short distance of the base of the Rocky Mountains; southward, for more than 1600 miles to the States of Iowa and Illinois: eastward, into the basin of Hudson Bay; and northward, into the Arctic Ocean.

He applies the name Keewatin Glacier to this central continental ice-sheet, which in general character appears to have been somewhat similar to the great glacier of north-western Europe, with a centre lying near the sea-coast, a steep and short slope seaward, and a very much longer and more gentle slope towards the interior of the continent. But, remarked Mr. Tyrrell, there was this difference between the two, that the centre of the latter was over a high rocky country; while the centre of the former was over what is now, and was probably also then, a low-lying plain, on which the snow accumulated to such depths as to cause it to flow over country very considerably higher.

This great glacier, in the different stages of its retirement down gradually descending slopes, caused many temporary extra-Glacial lakes to be formed, which were drained one after another as it retired to still lower country. Before it had withdrawn from the Winnipeg basin, Mr. Tyrrell thinks that it was joined by an advancing glacier from the east, and in front of the two, Lake Agassiz, one of the largest of the extra-Glacial lakes, was formed. During the final stages, its general gathering-ground is believed to have moved still nearer to the coast of Hudson Bay, and to have broken into several separate centres; and Mr. Tyrrell notes that after its retirement the land in the vicinity of Hudson Bay stood from 500 to 600 feet below its present level, and gradually rose to its present height.

The shifting of the centres of glaciation at different stages of the Great Ice Age, to which Mr. Tyrrell referred, seems to be a well-recognised characteristic in North America, though it is diversely explained. Dr. G. M. Dawson, in the admirable summary of Canadian Geology in the new Handbook for Canada prepared for the Toronto meeting, notes that the western part of the Great Plains was invaded at an early stage by large glaciers issuing from the Cordilleran ice-sheet through the main valleys of the Rocky Mountains, while at a later period, when this ice had shrunk back, a newer series of glacial deposits was spread out in the same area, largely composed of Laurentian and Huronian débris transported from the north-east.

Dr. Dawson, while acknowledging that the evidence is not satisfactory, is still inclined to think that these latter deposits may be in part of marine origin, and that they indicate great relative and absolute changes of level in this region in Glacial times.

In eastern Canada also "it has been found by Mr. Chalmers that when the Laurentide Glacier invaded the lowlands to the west of Quebec, the Appalachian glacier had either greatly decreased or had vanished" (Handbook, p. 30).

In England the drift deposits of the eastern and midland counties show many similar indications of successive glaciation from different centres, and until recently the tendency has been, as in America, to ascribe the facts to the intervention of warm inter-glacial periods. But since it is now generally acknowledged that, given a sufficiently low temperature, the prime factor in the accumulation of the ice-sheets has been the excessive snowfall rather than the extreme cold, may not the whole of the phenomena have been due to the gradual shifting of the areas of greatest precipitation, brought about, as a secondary effect, by the growth of the ice-sheets themselves?

It will be observed that Mr. Tyrrell, in common with all American glacialists, has recognised an up-hill movement of the ice sheet. The possibility of such movement has frequently been questioned on our side of the Atlantic, in spite of the occurrence of transported boulders in various parts of the British Islands at levels considerably higher than their source. But the extent of the uplifts in such instances is slight as compared with that described by Prof. C. H. Hitchcock in his paper on the Southern Lobe of the Laurentian Ice-sheet.

Prof. Hitchcock pointed out that one great lobe of the Laurentide Glacier went southward through the Champlain and Hudson valleys, moving from a plain near sea level, over the highest mountains in New England and New York, 6000 and 4000 feet in altitude, as shown by the transport of the boulders and by the direction of the glacial striæ. As indicative of the distinctiveness of this lobe he described how the striæ diverge from the central line "much like the barbs of a feather from the central shaft," and how the terminal moraines are looped round the area rudely at right angles to the direction of the ice movement. The initial gathering ground for this portion of the ice-sheet seems to have lain to the eastward of Hudson Bay; hence it is sometimes termed the Labradorian Glacier.

The lobate character of the southern termination of the ice and the tendency of these lobes to spread outwards from a centre is strongly insisted upon by all the American glacialists who have studied the peripheral portions of the glaciated area, and the delimitation of these lobes and the discussion of their chronological relations has been made the subject of much recent research. The matter is worthy of more attention than it has yet received with us, for as was shown by Mr. H. B. Woodward in a paper, read at Toronto, on the Chalky Boulder-clay of our West-midland counties, some at least of the characteristic phenomena can be recognised in this country also. The fact that in America these distinct lobes did not reach their maximum development at the same time, and that the overlapping of one great tongue upon the area previously occupied by another is frequently indicated, has given rise to much difference of opinion as to the length of the time-interval separating these different stages of growth and retreat. Prof. T. C. Chamberlin, who gave a lucid demonstration of his views[1] at Toronto, is of opinion that the glacial phenomena of the northern United States indicate two or more successive and distinct periods of glaciation separated by mild interglacial intervals, while other observers are inclined to agree with Dr. G. F. Wright, who though acknowledging wide oscillations of the ice-margin, regards the growth and wane of a single sheet as sufficient to account for all the facts.

In America, therefore, as in Europe, in spite of the prolonged discussion, not only is the number of the supposed warm inter-glacial periods still unsettled, but the evidence for even one such interval is challenged. The whole question is largely a legacy from the brilliant theorising of the late Dr. J. Croll, and with the breakdown of his captivating generalisations it has become necessary to reconsider the whole evidence which has been adduced, in support of them, on both sides of the Atlantic, before a safe conclusion can be reached. It is suggestive that while the explorers of the peripheral areas of the old ice-sheets are usually steadfast in their belief in such periods, those whose investigations lie more centrally to the regions of accumulation, both in Europe and in America, are more frequently in favour of the unity of the great glaciation. Yet even this localisation of opinion is capable of two opposite applications.

One of the strongest threads in the evidence for an inter-glacial period in North America is furnished by the sections in the vicinity of Toronto. Since Dr. G. J. Hinde described these deposits in 1877, fresh excavations in the Don Valley have revealed new facts of importance. Prof. A. P. Coleman, in his paper on the subject at the British Association meeting, stated that in the Don Valley a lowest till is seen, upon which rest 18 feet of sand and clay containing many unios and other shells, as well as leaves and pieces of wood. Some of the unios do

[1] These are ably stated by Prof. Chamberlin in the chapter on the Glacial phenomena of North America in the third edition of Prof. Jas. Geikie's "Great Ice Age."

not now live in Canadian waters, but are found in the Mississippi; and several species of trees now belonging to the States to the south occur with them, indicating a climate decidedly warmer than the present. Above this come stratified clay and sand, with a caribou horn and remains of insects and plants belonging to a colder climate than the present. This set of clays and sands is best shown in the cliff-section at Scarborough Heights a few miles to the east, where the series rises 148 feet above Lake Ontario, and contains many species of extinct beetles, as well as shell-fish, mosses, and wood of hardy trees. A complicated middle till overlies these beds which were deeply eroded before the advance of the ice. Another less important fossil-bearing bed occurs above the middle till at elevations up to 240 feet above the lake, and is followed by a third till. Prof. Coleman notes that great changes have occurred in the level of the water, the lake being much lower than at present before the first glacial advance and after the first interglacial time, and that during the deposition of the middle till, and also while the last sheet of till was being deposited, the water stood from 250 to 300 feet above the present level of the lake, which is 247 feet above the sea. In his opinion the length of time required for the first interglacial period is probably to be estimated at thousands of years; and during this time he thinks the ice-sheet of the Laurentide Glacier must have completely disappeared.

As a result of this paper a British Association Committee was appointed to investigate these deposits further by means of excavations. The palæontological evidence is held to imply that, as above stated, the climate when the Don Valley deposits were laid down was such as would be incompatible with the presence of ice anywhere in the Laurentide area, and that this warm period was followed by a later glaciation, of which the clearest evidence is contained in the section at Scarborough Heights. The identification of the warm-climate horizon in this cliff-section is especially desirable, and is one of the results which may be hoped from the Committee's investigations.

In describing the drift phenomena of the Pacific coast around Puget Sound, which in most respects compare very closely with those of our own islands, Mr. Bayley Willis put forward the hypothesis that the channels of the Sound, which have usually been considered submerged valleys, are the hollows remaining after repeated glacial invasion of a wide and diversified depression, during which the earlier divides were built upon, and transformed into plateau-like eminences of glacial drift, whereas the occupation of the valleys by glacial ice, particularly in the stagnant stages of retreat, prevented their being permanently filled; so that with the final retreat of the ice the moulds of glaciers remained as the channels of the Sound.

This view accentuates the undoubted fact that the accumulation of glacial débris has been greater around the margins of the old ice lobes than in the more central areas, and it may be applied to some extent to our own islands, where the persistence since pre-glacial times of the shallow basins of the North Sea and the Irish Sea appears to indicate that a larger proportion of the material transported by the ice-sheets which once filled them has been deposited around their margins than within their beds.

The old lake-beaches, incidentally referred to by Prof. Coleman and Mr. Tyrrell, occupy a large place in the studies of the American glacialists, while in the British islands, in spite of the rough pioneer work of the late Prof. Carvell Lewis, the subject has scarcely been touched. The scope for these researches in our country is, of course, limited; but the classical example of the parallel roads of Glen Roy is sufficient to prove that the phenomena are not unrepresented. In America two distinct types of old lakes have been recognised—those like Lake Agassiz and Lake Warren, which were formed in front of the retreating ice-margin, and those like Lake Nipissing and Lake Iroquois, which owed their position to differential earth movements.

The literature in regard to both types is already very extensive, and is not altogether satisfactory. Especially in the case of the glacially-dammed waters, their reputed vast extent, their impersistence of level and brief duration, the later modification of their sites by earth movements, and above all the obscurity of their traces over wide tracts of uncleared forest, makes it certain that while the broad fact of their former existence may be undoubted, the delimitation and correlation of their boundaries must be regarded in most cases as more or less provisional. With gravelly deposits of all kinds spread over such an enormous extent of territory it must necessarily be difficult to pick out an individual shore-line unless this can be traced almost continuously, which is rarely possible. In certain regions, however, the study has been carried on under more favourable conditions, with most interesting results. Thus Prof. H. Leroy Fairchild, in describing the glacial phenomena of Western New York,[1] showed how the long upland valleys of that part of the State contain the terraces of lakes which have overflowed southward across the watershed, leaving well-marked channels of glacial drainage, and how as lower passes were opened by the retreating ice the waters of these lakes sank to corresponding levels. The highest of the continuous shore-lines of this region is recognised as being that of the glacial Lake Warren, which is believed to have stretched from the western end of the basin of Lake Ontario over the whole or the greater part of the Great Lakes.[2]

Below this are found several less continuous terraces, probably marking different stages of the depletion of the lake, until at about 500 feet lower the Iroquois shore-line is reached, which appears to have been the immediate forerunner of the Lake Ontario of the present day. This beach is admirably developed in the vicinity of Toronto, and the main facts regarding it were demonstrated by Mr. Gilbert and Dr. Spencer during the meeting. Dr. Spencer considers that it is an old sea-beach; but in this he is at variance with most of the American glacialists, who hold that it, like the higher beaches, is of fresh-water origin.

These old beach-lines are of especial importance in that they reveal considerable differential uplift during late-glacial and post-glacial times. On this point all the students of the subject are agreed, and it is, of course, regarded therefore as a factor of prime importance in the later history of the lake basins. It was insisted upon by Mr. F. B. Taylor in an interesting communication on the relation of the Champlain submergence to the Great Lakes and to Niagara Falls. Working on the same lines as Mr. Gilbert had done, Mr. Taylor showed that an old shore-line, named the Nipissing Beach, surrounds a large portion of the Upper Great Lakes, and leads to a low col at the east end of Lake Nipissing. The formation of this beach he supposes to have been contemporaneous with the Champlain submergence by which the St. Lawrence Valley and the Champlain depression became arms of the sea, so that during this period the Upper Great Lakes had their outlet by way of the Nipissing Pass and the Ottawa River into the St. Lawrence, leaving only the discharge of Lake Erie, or one-ninth of the total volume, to occupy the Niagara River. Mr. Taylor stated that the Nipissing beach is tilted so that it falls regularly towards S. 27 W. at the rate of nearly 7 inches to the mile, being 110 to 115 feet above the present surface of the north-eastern part of Lake Superior, while not far east of Duluth it has sunk to the water level, and if its plane were projected it would pass 100 feet below the lake-level at Chicago. He gave reasons for considering that the tilting was caused by the same uplift which raised the Champlain Valley, and that one effect of this movement was to close the Nipissing outlet and to open that at Port Huron, by which the entire discharge of the lakes was sent into the Niagara. The result of these changes is to be found, according to Mr. Taylor, in the cañon below the Falls, the narrow and shallow gorge of the Whirlpool Rapids indicating the work of the comparatively feeble stream from Lake Erie, while the Upper Great Gorge has been excavated since the closing of the Nipissing outlet, which, accepting the known rate of recession of the Horse-shoe Fall as the principal datum, may have taken place from 5000 to 10,000 years ago.

These researches may well serve to illustrate the complexity of the problem whenever an attempt is made to transmute the term of geological processes into an equivalent in years. Simple multiplication and division without a steady-going chronometer can never suffice, nor is the time-unit that serves for a man's life ever likely to help us much in measuring the duration of cosmic processes.

As regards the differential movement, Spencer and Gilbert are of opinion that it is still in progress, and will eventually submerge Chicago and dry up Niagara. In a recent paper[3] Gilbert has even ventured to predict in years when this may be expected.

G. W. L.

[1] This paper is printed in full in the *Geological Magazine*, and is therefore easily accessible to British geologists.

[2] An admirable summary of the work of Spencer, Gilbert, and others in elucidating the history of this great body of water will be found in a paper by Mr. Warren Upham on "Glacial Lakes in Canada," *Bull. Geol. Soc. of Am.*, vol. ii. (1891) pp. 243–276.

[3] "Modification of the Great Lakes by Earth Movement," *U.S. Nat. Geographic Mag.*, vol. viii., September 1897, p. 233 (see NATURE, December 30, 1897).

MIERSITE, A CUBIC MODIFICATION OF NATIVE SILVER IODIDE.

SILVER IODIDE is remarkable in being one of the few substances which undergo a contraction in volume as the temperature increases. This contraction is uniform until about 146° C. is reached, when there is a further sudden contraction of considerable amount, after which the substance expands. The sudden contraction at 146° is accompanied by a change in all the physical properties of the substance, the pale yellow, hexagonal modification which exists at ordinary temperatures, being then changed into a bright yellow, cubic modification. On cooling the reverse phenomena are observed.

From this behaviour it would be expected that only the pale yellow, hexagonal modification would be found as a natural mineral, and as a matter of fact the only pure silver iodide so far known is the hexagonal species iodyrite. The existence of a cubic modification has, however, long been suspected from the occurrence of iodine in the cubic mineral iodobromite ($2AgCl.2AgBr.AgI$). This probably represents the artificial cubic modification which is stable above 146°, in which case the natural crystals of iodobromite should be pseudo-cubic; in fact, pseudomorphs of the hexagonal modification with the external form of the cubic modification. This would be strictly analogous to the pseudo-cubic leucite and boracite, which become isotropic when heated to a definite temperature.

The new mineral, miersite, is, however, quite distinct from these, and proves that silver iodide is trimorphous. The principal characters of the three modifications are :—

Iodyrite	Miersite	Iodobromite
Hexagonal	Cubic	Cubic
Hemimorphic	Tetrahedral	Holohedral
Twin plane, a pyramid face	A tetrahedron face	Not twinned
Cleavage, perfect basal	Perfect dodecahedral	Indistinct octahedral
Optically uniaxial	Isotropic	Optically anomalous?
Sectile	Brittle	Sectile

Between these there is a remarkable crystallographic relation: when a regular octahedron is considered as a rhombohedral crystal, the angle 70° 32′ corresponds to the angle 70° 36′ between the basal plane and a pyramid of iodyrite; the tetrahedrism, twinning, and sometimes the peculiar development of the miersite crystals make this relation still more striking.

Iodyrite, in all its crystallographic characters, is practically identical with wurtzite (ZnS), greenockite (CdS), and zincite (ZnO); these are all hexagonal and hemimorphic, possess a basal cleavage, and are optically positive, while the axial ratios vary only very slightly ($a : c = 1 : 0{\cdot}8109 - 1 : 0{\cdot}8196$). Many other substances may perhaps be included in this series, *e.g.* ice, magnesium, cadmium iodide, tridymite (SiO_2), &c. In the same way the dimorphous cubic modifications miersite, blende (ZnS), and marshite (CuI) form another parallel series, since they are all exactly alike in crystallographic characters.

It will now be seen that the same relation exists between iodyrite and miersite as exists between wurtzite and blende. This forms, as far as crystallographic characters are concerned, a perfect example of an isodimorphous group, but apparently the only relation existing between zinc sulphide and silver iodide is that their simplest conceivable chemical molecules contain two atoms.

From these somewhat remarkable relations one is inclined to ask: why should there not be a third modification of zinc sulphide to correspond with iodobromite? or why should not all these substances (*e.g.* ice, &c.) be dimorphous or trimorphous to fill up the gaps in these parallel series? Further, if nantokite and marshite are to be represented by the formulæ Cu_2Cl_2 and Cu_2I_2 respectively, then miersite should be Ag_2I_2: these double molecules, however, only depend on the vapour density of cuprous chloride, but the gaseous molecule cannot be the same as the crystal molecule, especially when there are, as in silver iodide, possibly three types of the latter.

A detailed description of miersite will be published in the *Mineralogical Magazine*. It may now be mentioned that the two specimens preserved in the British Museum collection are from the Broken Hill silver mines in New South Wales; the associated minerals on one specimen are quartz, copper glance, and garnet, and on the other, malachite, wad and anglesite. The small crystals of miersite, which do not exceed 2 mm. in diameter, are scattered over the surface of the matrix; they are of a pale or bright yellow colour, with an adamantine lustre. The only forms present are the cube and one or both of the tetrahedra, the latter usually differing in size but not in surface characters. In many respects the mineral is strikingly similar to the yellow blende which occurs in the white dolomite of the Binnenthal in Switzerland. The bright yellow streak is sometimes deeper in colour than the crystals themselves; this is strikingly shown by perfectly colourless and transparent crystals of marshite, which also give a bright yellow streak. Exposure to bright sunlight for several days does not affect the colour of the crystals. The silver is in part replaced by copper, and as this increases in amount, there is a gradual passage from miersite to marshite: "cuproiodargyrite" (AgI.CuI) from Chili is possibly an intermediate member of this group.

The new mineral has been named in honour of Mr. H. A. Miers, F.R.S., Professor of Mineralogy at Oxford, who first correctly determined the crystalline form of marshite, a mineral so closely resembling miersite in appearance that the two species are only to be distinguished by chemical tests.

L. J. SPENCER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Maryland Senate has passed a Bill granting 50,000 dollars a year for two years to the Johns Hopkins University.

DR. CHARLES CHREE, Superintendent of Kew Observatory, has received the honorary degree of LL.D. from the University of Aberdeen.

MR. C. B. ROUSS, who gave 25,000 dollars for a physical laboratory building in the University of Virginia, has given an additional 10,000 dollars for the same object.

MR. CHESTER W. KINGSLEY, of Cambridge, Mass., has given several large gifts to various benevolent purposes, including the sum of 25,000 dollars each to the Newton Theological Seminary, Andover Academy, and Colby University; the two first named being situated in Massachusetts, and the last in Maine.

A COURSE of eight Yates lectures in Archæology will be commenced at University College, London, on May 4, by Mr. J. Romilly Allen. The subjects of the first two lectures are the origins of primitive art and the evolution of decorative art, and the general object of the course is to trace the developments of Celtic art.

THE first school of forestry in America has just been created by the legislature of the State of New York, to be connected with Cornell University, and the sum of 10,000 dollars has been granted to cover the expenses of the first year. The school is authorised to purchase forest lands to the extent of 30,000 acres in the Adirondack region.

THE University of Paris has (says the *Times*) arranged for a loan of 1,700,000 francs from the Crédit Foncier, repayable in 50 annual instalments, for the erection of new buildings in Paris and at Fontainebleau. The Faculty of Science is also about to order the construction at a cost of 25,000 francs of an equatorial, which, after figuring in the Exhibition of 1900, will be placed in the tower of the new Sorbonne.

AT the graduation ceremony of the Glasgow University on April 12, the honorary degree of Doctor of Laws (LL.D.) was conferred upon Mr. Alexander Duncan, Secretary and Librarian to the Faculty of Physicians and Surgeons, Glasgow; Mr. Douglas Dunlop, Secretary-General to the Department of Public Instruction, Cairo, Egypt; Mr. John Inglis, formerly president of the Institution of Engineers and Shipbuilders in Scotland, president-elect of the Institution of Marine Engineers, London; Dr. Elie van Rijckevorsel, of the Batavian Society of Experimental Philosophy, Rotterdam; and Prof. J. M. Thomson, F.R.S., professor of Chemistry in King's College, London.

THE excursions of the London Geological Field Class will begin on Saturday, April 23, with a visit to Dorking, Box Hill,

and Betchworth; and between that date and the middle of July the country from Aylesbury to Cuckfield will be systematically examined by the class so as to draw a section over the trough of the Thames basin, and see the deposits to the north and south of London, which underlie the rocks associated with the chalk. The class has been organised and carried on by Prof. H. G. Seeley, F.R.S., for the past twelve years, without difficulty of any kind, and without assistance. It was established as a class to show that systematic instruction in geology could be given in the open country, and the example it affords must tend to bring about more practical teaching in the matter of field-work. When the class began there was very little of such teaching anywhere, but the value of individual observation is now accepted as a canon of scientific education, and the success of Prof. Seeley's work should encourage educationists in their endeavour to get the fact-knowledge entirely substituted for the word-knowledge of books.

SOCIETIES AND ACADEMIES

DUBLIN.

Royal Dublin Society, March 16.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Prof. J. Joly, F.R.S., and Dr. H. H. Dixon read a paper on the distribution of coccoliths and on some microscopic organisms found in Dublin and Killiney Bays. Coccoliths have been found by the authors on the Irish coast at Sligo, Slyne Head, Dingle, Waterville, and along the coast of south Co. Dublin, and on the south coast of England at Weymouth. Samples of water from Loch Inver and Portstuart did not afford any examples. Coccoliths were also found in the mud obtained in the Severn and Liffey beds. In the paper are also described a new marine Difflugia and organisms from Killiney Bay resembling Ehrenberg's Pyxidicula and Xanthidia from the chalk.—A paper by Prof. W. Noel Hartley, F.R.S., and Mr. Hugh Ramage was then read by the former, the subject being a determination of the wave-lengths of the principal lines in the spectrum of gallium, showing their identity with two lines in the solar spectrum. The authors have found gallium to be a very widely distributed element in the earth, and to be present also in meteoric bodies. It became natural to inquire if it is present in the sun. The wave-lengths of the two principal lines have not previously been determined by a grating spectrograph, and the authors availed themselves of the kind offer of Dr. Adeney to allow them to photograph spectra of gallium with the 21½ feet radius grating spectrograph in the Physical Laboratory of the Royal University of Ireland. The two principal lines were photographed as bright and reversed lines in arc spectra, and as bright lines in the spark spectrum of a solution of gallium chloride. In these and in the oxyhydrogen spectrum of gallium compounds the less refrangible line is always stronger than the other. The wave-lengths of the two lines, determined by interpolation from adjacent iron lines, are found to be 4172·215 and 4033·125. In Rowland's map of the solar spectrum there are two lines probably identical with these, namely:—

4172·211. Source: Aluminium. Intensity: 1,
and 4033·112. Not identified. ,, 00.

It is pointed out that gallium is present in every bauxite and shale examined by the authors, and also in metallic aluminium, and no doubt the line 4172·211 in the spectrum of aluminium is really a gallium line. From the very close agreement of the wave-lengths, from the relative intensities of the lines as shown above, and from the evidence of the wide distribution of the element, it seems certain that the two gallium lines are identical with the two lines above mentioned in the solar spectrum, and there are no other lines so close to these. The evidence is discussed at length in the paper, as also is the effect of the presence of elements upon the spectra of other elements.—Prof. J. P. O'Reilly read a paper on the occurrence of anatase and brookite in the quartzites of Shankill, Co. Dublin. He explained that the minerals were found in a mass of yellow earth, met with by the quarrymen in 1888, and had only lately been examined. The peculiarity of the anatase was its approximation in composition to the clay or mineral analysed by Eakins as mentioned by Dana in his "System of Mineralogy," edition of 1892, p. 716, while presenting the crystalline form of anatase, thus allowing of the presumption that the clay analysed by Eakins and called by him "Xanthitane," was probably the product of decomposition of an anatase having much the same composition as the mineral found at Shankill.

EDINBURGH.

Royal Society, March 21.—Lord Kelvin, President, in the chair.—Lord Kelvin, in a paper on thermodynamics, deduced from motivity, fulfilled a promise made twenty-one years ago to the Society. After referring to the somewhat misleading phrase, *the mechanical equivalent of heat*, and pointing out the necessity of having a single word to express the availability of heat for transformation into useful work, he proceeded to show that the whole of thermodynamics was contained in the two equations

$$de = \mathrm{J}N\,dt + \Sigma(P\,dg + \mathrm{J}M\,dg)$$
$$dm = \mathrm{J}\frac{t-\mathrm{T}}{t}N\,dt + \Sigma\left(P + \mathrm{J}\frac{t-\mathrm{T}}{t}M\right)dg$$

where e is the energy, m the motivity, t the temperature of any part of the system, T the lowest temperature in the system, g any coordinate, P the corresponding force, and N, M specific heats. The usual equations are at once deduced by treating de, dm as complete differentials.—Dr. Galt, of Glasgow University, communicated a paper on the microscopical appearances of the grains in the more commonly occurring starches. The paper was full of detail, and was illustrated by numerous original photographs and lantern slides. In a paper on methods of mapping rainfall, Mr. A. J. Herbertson described a simple graphical method for taking into account the varying lengths of periods of observation of rainfall at different parts of the globe. The mean rainfall values were inserted on the maps in different coloured inks, according to the length of period of observation. The general trend of the isohyets could be attained by comparing similarly coloured means, and the final positions of the lines fixed by the values at the stations with the most extended records. The variableness in the length of the month is allowed for by drawing isohyetal lines, whose actual values are the nominal values multiplied by the days in the corresponding month, and divided by one-twelfth of a year expressed in days. In a second paper, on the normal rainfall of India and the abnormalities in 1896, Mr. Herbertson showed maps on the mean annual and monthly rainfall of India, based on the means published in the rainfall data for 1895, and those in the annual summary for 1896.

Royal Physical Society, March 16.—Mr. B. N. Peach, President, in the chair.—Papers were read by Mr. W. S. Bruce, of the Jackson-Harmsworth expedition, and Mr. William Eagle Clark, on the mammals and birds of Franz Josef Land. Mr. Bruce, who spent fifteen months on Franz Josef Land in 1896-97, explained that the number of species, exclusive of mammals and birds, he then obtained exceeded that of any previous Arctic expedition, he having secured 236 against 216 to the credit of the United States expedition of 1881-83. He had at least doubled the number of species known to Franz Josef Land. He had found ancient reindeer horns, though there were no reindeer at present in the Land. Among the specimens he exhibited were the bones of whales and walruses found on raised beaches with an elevation of from 50 to 80 feet, plainly indicating their great age; while one specimen—the scapula of a walrus—was found at a height of 336 feet. The chief point of interest in Mr. Clark's part of the subject, which was restricted to birds, was the finding of several new species—Bonaparte's sandpiper, purple sandpiper, and the shore lark. The first mentioned of these, Mr. Clark said, was not only a new and remarkable addition to the ornis of Franz Josef Land, but it was the first authentic example of this American species that had been obtained in Europe elsewhere than in the British Isles. Another subject of interest in the paper was the description of a newly-found nesting-place of the ivory gull. This was at Cape Mary Harmsworth, on what was considered to be one of the largest pieces of bare ground in Franz Josef Land. Of the twenty-two species of birds which formed the avifauna of Franz Josef Land, only ten had been found breeding, though several more undoubtedly nested there, while several, again, were mere stragglers.

PARIS.

Academy of Sciences, April 4.—M. Wolf in the chair.—On a doctrinal point in the theory of quadratic forms, by M. de Jonquières.—Contribution to the study of Zeeman's phenomenon, by MM. Henri Becquerel and H. Deslandres. An account of some experiments on the influence of a magnetic field upon the periods of vibration of the radiations emitted by incandescent vapours.—Movements of the sensitive plant when grown in water, by M. Gaston Bonnier. The author has succeeded in cultivating *Mimosa pudica* completely immersed in

water, and has studied in detail the alterations in structure and movement brought about by the new conditions of life.—On the deformation of compressed parts and the stability of large frame-works, by M. A. Bérard.—On congruences which are in several ways K congruences, by M. C. Guichard.—New expression of the elements of an orthogonal system by *theta* functions of two arguments and their application in dynamics, by M. E. Jahnke.—On a transformation of Hamilton's equation, by MM. W. Ebert and J. Perchot.—On the deformations experienced by a solid dielectric on becoming the seat of an electric field, by M. Paul Sacerdote. The phenomena in question are shown to be deducible from the principles of the conservation of energy and of electricity.—On a problem in the analytical theory of heat, by M. W. Stekloff.—On the electric conductivity of solutions of permanganate of potassium, by M. Emmanuel Legrand. The molecular conductivity increases with the dilution, and approaches the limiting value 124 obtained by former experimenters for neutral salts at 25° C.—On multiple resonance, by M. Louis Décombe.—On the thermic mercurial ampère-meter and its industrial applications: new standard of electromotive force, by M. Charles Camichel.—Comparison of the atomic weights of hydrogen, nitrogen, and carbon deduced from physical data with their values as deduced from chemical analysis, by M. Daniel Berthelot. The author claims that the calculation of atomic volumes and atomic weights from accurate determinations of the density and compressibility allows of the confirmation and, in certain cases, of the statement with precision of the results given by chemical analysis. The results obtained by various observers in the case of the three elements mentioned are criticised in detail.—Isoquinoline and tetrahydroisoquinoline, by M. Marcel Delépine. A thermo-chemical study.—On the estimation of small quantities of carbon monoxide in air and in normal blood, by M. L. de Saint-Martin. The author, in reply to the criticisms of M. Gautier, further explains the analytical modifications introduced by him. A series of experiments are described to demonstrate the presence of carbon monoxide in the blood of animals living in large towns.—On the spectrum and the nature of neodymium, by M. Eug. Demarçay.—Action of oxidising agents on some nitrogenous bodies, by M. Œchsner de Coninck. An account of the action of hypochlorites, in presence of excess of alkali, upon amines, diamines, hydrazines, cyanic and cyanuric acids, and various alkaloids.—Combination of mercuric nitrate and trimethyl carbinol, by M. G. Denigès. The author describes the preparation and properties of a new compound, which he terms mercuroso-mercuric dimethylethylenic nitrate.—On the physiology of gentianose; its hydrolysis by soluble ferments.—Detection of wood saw-dust in flour, by M. G. A. Le Roy. The suspected sample is gently warmed with an alcoholic solution of phloroglucinol, strongly acidified with phosphoric acid. The particles of saw-dust are stained an intense carmine-red colour, while the starch and cellulose of the grain itself are little, or but slightly, affected.—On the crystalline forms of the *oligist* of Puy de la Tache (Mount Dore), by M. F. Gonnard.—On the micro-organisms of "turned" wines, by MM. F. Bordas, Joulin, and de Raczkowski. The authors have isolated and studied an organism, which they propose to term *Bacillus roseus vini* from the colour assumed by its cultivations in certain media.—Effects of the solar and lunar attractions upon the atmosphere of the northern hemisphere at each of the four phases, by M. A. Poincaré.

DIARY OF SOCIETIES.

FRIDAY, APRIL 15.

MALACOLOGICAL SOCIETY, at 8.—On some New Species of Land Shells from South America: S. I. Da Costa.—Note on the Anatomy of *Resania*, Gray, and *Zenatia*, Gray: W. H. Dall.—Note on the Anatomy of *Mülleria*: M. F. Woodward.

MONDAY, APRIL 18.

SOCIETY OF ARTS, at 8.—Sources of Commercial India-rubber: Dr. D. Morris, C.M.G.

VICTORIA INSTITUTE, at 4.30.—The Design of the Human Foot: Gerard Smith.

TUESDAY, APRIL 19.

ZOOLOGICAL SOCIETY, at 8.30.—On the Breeding of the Dragonet (*Callionymus lyra*): Ernest W. L. Holt.—On the Serricorn Coleoptera of St. Vincent, Grenada, and the Grenadines, with Descriptions of New Species: Rev. H. S. Gorham.—Note on the Affinities of *Palæospondylus gunni*, Traq.: Dr. Bashford Dean.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be discussed: The Electricity Supply of London: A. H. Preece.

ROYAL VICTORIA HALL, at 8.30.—X-Rays: Bruce H. Wade.

WEDNESDAY, APRIL 20.

SOCIETY OF ARTS, at 8.—Stage Mechanism: Edwin O. Sachs.

GEOLOGICAL SOCIETY, at 8.—Note on an Ebbing and Flowing Well at Newton Nottage, in Glamorganshire: H. G. Madan.—*Petalocrinus*: F. A. Bather.—On the Origin of the Auriferous Conglomerates of the Gold Coast Colony (West Africa): T. B. F. Sam.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Anticyclonic Systems and their Movements: Major H. E. Rawson.—Results of Observations on Haze and Transparency in 1897: Hon. F. A. Rollo Russell.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—An Exhibition of Diatoms: H. Morland.—At 8.—On some Organic Substances of High Refractivity available for Mounting Specimens for Examination under the Microscope: H. G. Madan.—Instantaneous Photomicrography: E. B. Stringer.

THURSDAY, APRIL 21.

SOCIETY OF ARTS (Indian Section), at 8.—Recent Railway Policy in India: Horace Bell.

LINNEAN SOCIETY, at 8.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Cost of Generation and Distribution of Electrical Energy: R. Hammond. (Continuation of Discussion.)

CHEMICAL SOCIETY, at 8.—The Carbohydrates of Barley Straw: C. F. Cross, E. J. Bevan, and Claud Smith.—Isomeric Bornylamines: Dr. M. O. Forster.—Some Derivatives of Benzophenone: Dr. F. E. Matthews.—Researches on Camphoric Acid: Dr. S. B. Schryver.—Ballot for Election of Fellows.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Barometrical Determination of Heights: F. J. B. Cordeiro (Spon).—A Manual of General Pathology for Students and Practitioners: Dr. W. S. Lazarus-Barlow (Churchill).—Practical Radiography: A. W. Isenthal and H. S. Ward, 2nd edition (Dawbarn).—Elementary Chemistry: T. A. Cheetham (Blackie).—Synopsis Characearum Europaearum: Dr. W. Migula (Leipzig, Kummer).—Accounts of the Trade carried by Rail and River in India in the Official Year 1896-97 and the Four preceding Years (Calcutta).—Notes on Observations: S. Lupton (Macmillan).—An Elementary Course of Physics: edited by Rev. J. C. P. Aldous (Macmillan).—Essays on Museums, &c.: Sir W. H. Flower (Macmillan).

PAMPHLETS.—Some New Indo-Malayan Orchids: G. King and R. Pantling (Calcutta).—A Simple Guide to the Choice of a Photographic Lens: T. R. Dallmeyer (J. H. Dallmeyer).

SERIALS.—Knowledge, April (High Holborn).—Bulletin of the American Mathematical Society, March (N.Y., Macmillan).—Transactions of the Astronomical and Physical Society of Toronto, 1897 (Toronto).—Observatory, April (Taylor).—Atlantic Monthly, April (Gay).—Journal of the Sanitary Institute, April (Stanford).—Zeitschrift für Wissenschaftliche Zoologie, lxiii. Band, 3 Heft (Leipzig, Engelmann).—Materials for a Flora of the Malayan Peninsula: Sir G. King, No. 10 (Calcutta).—History of Mankind: F. Ratzel, translated, Part 25 (Macmillan).—Psychological Review, Monograph Supplements, Vol. 2, No. 2 (Macmillan).—Reliquary and Illustrated Archæologist, April (Bemrose).—Mind, April (Williams).

CONTENTS.